CHAPTER 3
AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

Chapter 3 describes the physical, biological, social, and economic environment and the potential effects on the human environment of the Proposed Action and other alternatives described in Chapter 2. This format eliminates the redundancy created when the affected environment and the environmental consequences are discussed in separate chapters. Chapter 3 is organized by resource, allowing the reader to better review and understand the existing situation and the potential environment impacts of all the alternatives by resource.

Except for BLM-administered lands that are under wilderness review, the proposed regulations apply to all operations authorized by the mining laws on public lands administered by BLM, including Stock Raising Homestead lands where the mineral interest is reserved to the United States. Mineral activity on BLM-administered lands under wilderness review are subject to the requirements at 43 CFR 3802. In addition, public lands open to mineral entry under the mining laws but not administered by BLM (national park, national forest, and national wildlife refuge lands) are not covered by the proposed regulations. Mineral disturbances on these lands are regulated by the relevant federal land managing agency, i.e. National Park Service, U.S. Forest Service, and U.S. Fish and Wildlife Service.

Most public lands open to activities under the mining laws are in the 11 contiguous western states, plus Alaska. (See Table 3-1.) Within the study area, BLM administers a surface and mineral estate of about 260 million acres. In addition to this surface/mineral estate, BLM also administers 300 million more acres of mineral estate underlying other lands. The surface of 70 million acres of these mineral estate lands were patented under the Stock Raising Homestead Act. By statute these patents had the mineral estate retained by the Federal Government and kept the lands open to mineral entry under the mining laws.

The study area accounts for about half of the total acreage within the United States, but 99% of all public lands administered by BLM are within the 12-state study area. BLM-administered public land acreage as a percentage of the total acreage within each state within the study area ranges from less than 1% in Washington to more than 68% in Nevada. In addition, 95% of the lands patented under the Stock Raising Homestead Act, where the mineral estate was retained by the Federal Government, are also within the study area. Almost half of these split-estate lands are located in New Mexico and Wyoming.

Table 3-1. Distribution of BLM-Administered Public Land, Stock Raising Homestead Act Acreage, and Total State Acreage			
States	Public Land Acreage[1]	SRHA Acreage	Total State Acreage
Alaska	86,526,170	0	365,481,600
Arizona	14,225,888	2,985,746	72,699,000
California	14,565,597	3,423,222	100,206,720
Colorado	8,328,739	8,405,015	66,485,760
Idaho	11,789,324	3,563,294	52,933,120
Montana	6,225,205	7,720,173	93,271,040
Nevada	47,883,408	494,637	70,264,320
New Mexico	13,149,476	15,621,192	77,766,400
Oregon	16,143,043	3,375,688	61,598,720
Utah	22,769,356	2,800,709	52,696,960
Washington	386,334	513,746	42,693,760
Wyoming	18,356,977	18,172,713	62,343,040
Total Study Area	260,349,517	67,076,135	1,118,440,440
Other States:[2]	1,531,061	3,286,790	1,152,902,920
Total U.S.	261,880,578	70,362,925	2,271,343,360
Study Area as Percent of U.S.	99%	95%	49%

[1] Includes all public lands administered by BLM except for Land Utilization Project lands, to which the 3809 regulations do not apply. Also includes lands that are withdrawn and segregated from mineral entry.
[2] Includes Alabama, Arkansas, Florida, Illinois, Iowa, Kansas, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, N. Dakota, Oklahoma, S. Dakota, and Wisconsin.
Sources: BLM 1999a, 1979.

Public lands in the 12-state study area have a wide range of climates, landforms, vegetation types, and social and economic settings. Physical characteristics such as climate and soil types and biological parameters such as vegetation productivity and the presence of special status species differ markedly. The physical and biological attributes described in this chapter highlight these differences only where needed to describe the affected environment in relation to the regulatory alternatives.

The Proposed Action and alternatives analyzed in this chapter consist of potential changes in the regulations that are set forth to prevent unnecessary or undue degradation of public lands by operations authorized under the mining laws. Environmental consequences that would result from these potential regulatory changes can be categorized and presented in many ways. Some impacts are the direct effect of implementing the action, whereas others are more indirect, occurring later or further away. The impacts may last for only a short time or may affect the environment for a long period. The environmental consequences may be adverse, beneficial, or both. Many of the potential regulatory changes would be largely administrative and would have little direct effect on the environment. These administrative changes are aimed at improving agency efficiency and effectiveness, increasing consistency, or meeting other nonenvironmental objectives or public policies.

The administrative changes would, however, result in indirect or secondary effects on physical, biological, social, or economic aspects of the environment. Chapter 3 discusses all aspects of the environmental consequences of the Proposed Action and other alternatives. But the environmental impacts of future on-the-ground disturbances, requiring National Environmental Policy Act compliance, will be analyzed on a case-by-case basis.

As this EIS was prepared to evaluate the environmental consequences of regulation alternatives, it was not practical to document the affected environment or environmental consequences at the level of detail generally found in site-specific EISs. The regulatory alternatives will affect the nature, extent, and environmental consequences of future mineral activity on public lands administered by BLM. The uncertainties of where, when, and how this future mining will occur make accurate long-term forecasts impossible and even short-term projections tenuous. But to aid in the analysis, reasonably foreseeable assumptions on future activity were prepared (Appendix E). These assumptions became the basis for much of the environmental consequences discussed in this chapter. The approach used to document the reasonably foreseeable significant effects conforms to the requirements at 40 CFR 1502.22 when dealing with situations where information is incomplete or unavailable. Approval of future mineral activity, subject to National Environmental Policy Act, will be documented and analyzed at a level of detail commensurate with the proposed on-the-ground disturbance.

ASSUMPTIONS FOR ANALYSIS

The analysis of the environmental effects of the Proposed Action and alternatives is based on the following assumptions.

Full Implementation. To clearly give a scientific and analytic basis for comparing the regulatory alternatives, we assume full implementation of each regulatory alternative. This assumption allows us to more sharply define the environmental consequences of the regulatory options to aid in decision making. Full implementation requires adequate agency funding and staffing to ensure that all the provisions of the proposed regulations and alternatives are fully implemented.

No Action Alternative. The No Action Alternative (Alternative 1) assumes that the existing regulations continue unchanged. Although it assumes no change in the existing regulations, this alternative still may have environmental consequences. Future mineral activity under the No Action Alternative is presented as a set of assumptions. These assumptions are fairly general, given the diversity of mining on public lands, variety of mining and exploration methods, commodities extracted, geographic scope, and inherent uncertainty of the commodities markets. These assumptions concerning the future under the No Action Alternative are discussed in Appendix E.

Changes in Mineral Activity. Estimates of mineral activity for Alternatives 2, 3, 4, and 5 are presented as changes from the baseline (No Action Alternative). As with the assumptions for future mineral activity, it is neither practical nor even possible to develop complete information on future changes in mineral activity resulting from the implementing of regulatory alternatives. Appendix E discusses the approach used to document the reasonably foreseeable significant effects. This approach conforms to the requirements at 40 CFR Part 1502.22 for situations where information is incomplete or unavailable. The changes in mineral activity estimates are intended to help evaluate the environmental consequences of the proposed regulations and alternatives, specifically to give the public and decision makers information on the potential direction and magnitude of change. These estimates of the expected changes in mineral activity should not be considered factual data or accurate or precise estimates of change. Because of the uncertainties in forecasting and the many comments received on the estimates presented in the draft EIS, the team opted to present the estimates of changes in mineral activity as ranges.

Past, Present, and Future Actions and Events. The cumulative effects of past actions and events are reflected in the Affected Environment. These past actions and events include existing legal requirements and past and present public land uses and land use decisions. The existing legal federal requirements that are relevant to mineral exploration and mining are discussed in Appendix C. Appendix D presents a summary of the key state mining regulations. Where recent actions and events have taken place, we discuss the potential consequences to the affected environment. We note pending or future actions and events but do not attempt to speculate on the potential effects of these actions.

Discretionary Regulatory Provisions. Many of the provisions in the proposed regulations give BLM discretion on how, when, and where to implement the provision. Two provisions in the proposed regulations are of particular importance because of the potential magnitude of the impact on the industry and the environment. The backfilling requirement in the proposed regulations provides that *BLM will determine the amount of pit backfilling required, if any, taking into consideration economic, environmental, and safety factors.* In addition, the proposed definition of unnecessary or undue degradation has been expanded to include preventing ***...conditions, activities, or practices that...*** *result in substantial irreparable harm to significant scientific, cultural, or environmental resource values of the public lands that cannot be effectively mitigated.*

The proposed backfilling provision is similar to the existing State of Nevada requirements. A recent BLM study of the pit backfilling in Nevada reported that no major mine pits have been completely backfilled (BLM 1998d). About 25% of recently approved Plan-level operations with pits have been or are proposed to be partially backfilled. As such, for our analysis we assume that pit backfilling will generally be limited to situations that allow for concurrent pit reclamation, such as operations with multiple pits.

The proposed addition of the substantial irreparable harm to the unnecessary or undue degradation definition would apply to all operations under the proposed regulations, including casual use and Notice- and Plans-level operations. BLM will need to consider this provision when it approves or reviews a proposed action. The Preamble for the proposed regulations states that the intent is for this provision to be used to deny a Plan of Operations or reject a Notice only in exceptional circumstances. In addition, Section 3809.411(d)(3)(iii) provides that if BLM disapproves a Plan of Operations on the basis of this provision, it must include written findings supported by a record that clearly shows each element of the provision. The proposed regulations require that any decision to deny a Plan of Operations be based on this provision. Any decision to deny a Plan of Operations must be supported by documentation showing how the following four criteria have been met.

- Approval of the Plan of Operations would create irreparable harm.
- The irreparable harm is substantial in extent, duration, or magnitude.
- The resources undergoing substantial irreparable harm constitute significant scientific, cultural, or environmental resources.
- Mitigation would not be effective in reducing the level of harm below the substantial or irreparable threshold.

Consistent with this intent, we assume that BLM would rarely deny a Plan of Operations or reject a Notice on the basis of this substantial irreparable harm provision for most resources. But we also recognize that the determination of what constitutes substantial irreparable harm, significant resources, and effective mitigation is not always straightforward to BLM or the public. Of specific concern are activities that will potentially affect Native American sacred or religious values. One can argue that religious significance, substantial irreparable harm, and effective mitigation are determined by those that hold those beliefs, not by BLM. Analyzing the implementing and impact of this provision as it applies to sacred and religious values is further complicated by the fact that most the Native American religions are based on or incorporate the concept that each individual determines what is significant for herself/himself. Because of these concerns, we assume that this provision as it relates to sacred and religious values will be extensively applied.

CUMULATIVE EFFECTS

The regulations for implementing the National Environmental Policy Act (NEPA) require federal agencies to analyze and disclose *cumulative* effects—effects that result from the incremental impact of an action "when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1508.7)

The Proposed Action and alternatives involve changes in the regulations and as such are broad in scope. As a result, this EIS is programmatic, addressing environmental consequences that are correspondingly broad in scope. Furthermore, neither the Proposed Action nor the alternatives would be implemented in a vacuum. Implementation would be interwoven with many other actions, events, and trends taking place at local, regional, national, and international levels. For example, actions on federally administered lands may have beneficial or harmful impacts to systems on private lands. The analysis in this chapter strives to consider these changes.

For example, mineral activity is not the only factor that affects the public lands. Climate, recreation, livestock grazing and wildlife use, management practices on adjoining lands, and the introduction and spread of alien weeds are also key considerations. The future of the public lands cannot be predicted by considering changes in mineral activity and the 3809 regulations alone. Similarly, BLM regulations, management practices, and policies are not the only factors that affect the mining industry and western rural communities. Of major importance are currently undiscovered mineral deposits; local, national, and international supply and demand for mineral commodities; regional population growth; changing demographics, lifestyles, and values; economic competition and restructuring; and changing laws, policies, and practices being implemented by other federal and state agencies.

Population growth and demographic changes in the West and in many western rural communities will continue to transform rural economies. Population growth in many rural communities, while contributing to economic growth and diversification, will continue to diminish the relative importance of mining in those communities. Communities that continue to lose population and whose economies are in decline may be further strained by any decrease in mineral activity. Demographic and land use changes might increase or decrease a community's tax base. Where economies are stable or growing, the tax base would likely be stable. Where populations continue to decline or mineral production significantly declines, the state and local tax revenues might decline.

The protection and recovery of federally listed species and their habitats—for example, desert tortoises in the desert Southwest—are also likely to change the way mining activity is conducted on federal lands. Future activities designed to avert habitat loss and endangered species listings will be implemented under any of the regulatory alternatives considered in this EIS.

A fundamental assumption of this analysis is that, with or without changes to the 3809 regulations, the human environment within the study area will continue to change. The 3809 regulations are but one small factor in defining the future conditions of the human environment. The potential environmental consequences of the proposed action and alternatives, including the cumulative effects, are documented by resource in this chapter.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

A resource is irreversibly committed when an action alters the resource so that it cannot be restored or returned to its original or predisturbance condition. A resource is irretrievably committed when a resource is removed or consumed.

For example, in the extraction of gold, the mining of waste rock and ore would be an irreversible commitment of resources. Although the gold in ore would be irreversibly committed from geologic formations, the precious metal would be retrieved and placed in long-term economic circulation.

Another example of irreversible losses involves soil erosion. Soil losses from handling, erosion losses from topsoil stockpiles, and other unavoidable erosion losses would be irreversible. The net evaporative losses of water from a pit lake would be an example of a long-term irretrievable commitment of resources. Consumptive use of process water would be an example of a temporary irretrievable commitment of resources, occurring only during mining.

The level of future mineral activity under the Proposed Action or alternatives would directly affect the magnitude of the irreversible and irretrievable commitment of resources. But provisions of the alternatives would also define the nature and extent of these commitments. These types of irreversible and irretrievable effects are discussed as part of the environmental consequences of the alternatives for each resource in this chapter.

ENVIRONMENTAL JUSTICE

Federal agencies are required to address “disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations” (Executive Order 12898). During this analysis BLM considered all public input from persons or groups, regardless of age, race, income status, or other social and economic characteristics.

This document is a broad assessment of proposed regulations. Environmental Justice issues are meant to be addressed at the local level. As CEQ’s Environmental Justice Guidance under the National Environmental Policy Act states, “Agencies should recognize that the question of whether agency action raises environmental justice issues is highly sensitive to the history or circumstances of a particular community or population, the particular type of environmental or human health impact, and the nature of the proposed action itself.”

MINERAL RESOURCE DEVELOPMENT

Affected Environment

Geology

The public lands have a rich geologic history and an abundance of mineral resources. The geology on public lands is highly complex and difficult to summarize. The regions have been subdivided into geologic physiographic provinces such as the Basin and Range, Colorado Plateau, Snake River Plain, Rocky Mountain, and the Columbia Plateau, to name a few. The public lands includes geologic formations dating from the Archean (early part of Precambrian era) to the Quaternary period.

Gold is extensively produced in Nevada, copper in Arizona, placer gold in Alaska, and gypsum in California. Minerals extracted from the public land include copper, gold, silver, lead, mercury, uranium, perlite, bentonite, and limestone. The potential for continued mineral production on public lands is high, and the mineral industry continues to develop these lands for a variety of mineral products.

Understanding ore deposits is a complex and difficult task. But basic understanding of ore deposits is needed to understand the complex nature of the mining types and their impacts . The following passage is reprinted with permission from Appendix A of the National Research Council (NRC) study *Hardrock Mining on Federal Lands* (NRC 1999).

> Ore deposits form as variants of such geologic processes as volcanism, weathering, and sedimentation operating with an extraordinary intensity. Ore deposits typically are parts of large-scale (several miles across and perhaps just as deep) ore-forming systems in which many elements, not just those of economic interest, have been enriched. For example, arsenic, antimony, thallium, and mercury are commonly enriched in or near Carlin-type gold deposits. Explorationists continually seek to discern trace chemical haloes or geophysical patterns to combine with geological observations and concepts to recognize faint clues to the location of the ore deposit. Known ores constitute less than one part in 10,000 of the metal endowment of the upper 1 km of continental crust; thus, by far the largest portion of metals resides in ordinary rocks as a low-level background geochemical signature in amounts to meager for economic mining.
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> Many hardrock commodities are associated with magmatic and hydrothermal processes (Guilbert and Park, 1986). These processes, in turn, are associated with modern or ancient mountain belts. Mountainous or sparsely vegetated terrains, such as those in the western states, expose possibly productive rocks much more fully than do, for example, mid-continent prairies. In addition, the West is blessed with geologic conditions, including abundant igneous rocks and associated hydrothermal systems, that have led to the formation of ore deposits. Thus, the prime prospecting ground is in land that many people regard as valuable for aesthetic reasons, which creates potential for conflict among uses of the land.

Development of Mineral Properties

To understand how the 3809 regulations apply to mineral activities on public lands, one should review the steps or phases used to locate and develop mineral properties. The following is a description of the process the mining industry uses to develop mineral properties and the types of mining methods used to extract minerals.

All mining operations begin with exploration activities that require large dollar investments coupled with a high risk of failure. Success of mining depends on the success of exploration. Exploration may discover a mineral occurrence and may even outline its size and mineral character. The ore deposit is "found" or "developed" only through the combined efforts of the many geologists, geophysicists, geochemists, metallurgists, mining engineers, lawyers, and managers who believe that a mine can be profitably developed. Deposits go through many cycles of evaluation and rejection. Before they are brought into production, geologic understanding improves, and worldwide economic and political conditions change. The location of a mining claim or group of claims follows the prospecting or exploration program and is essential to the next phase of developing a mineral deposit into a mine.

The development of a mine from grassroots exploration to production can be roughly divided into three stages. Each stage requires applying more discriminating (and expensive) techniques over successively smaller areas to find, develop, and produce economic mineral deposits. These stages can be grouped into the following activity categories: reconnaissance, exploration/prospecting, and mine development.

The lag time between the first discovery of a mineral occurrence and the opening of a mine may be 10 years or more. Some gold properties are opened within 3 years, whereas copper deposits may require more than 10 years. During this time operators do the following:

- Analyze all available and reasonable geologic information.
- Make engineering decisions for the design of the mine.
- Acquire equipment and workers.
- Prepare mine closure and reclamation plans.
- Obtain financial capital.

Reconnaissance. The first phase of exploration involves researching the geologic literature; reviewing the geologic models for the minerals of interest; and interviewing local, knowledgeable, experienced people and companies working in the area of interest. Once reconnaissance has found a favorable area, usually occupying tens of square miles, it may use airborne and satellite remote sensing surveys and limited ground surveys to examine the general characteristics of the area's geology and mineralization and then select smaller targets of interest for more detailed study. Such study may involve detailed surface geologic mapping, geophysical surveying, and geochemical sampling programs, none of which disturb the land's surface. Academic and government entities or major corporations usually carry out these studies.

Reconnaissance-level mineral inventories normally cause no more surface disturbance than an occasional sampling of soil, rocks, or stream sediment. These inventories may require minor off-road vehicle use. To protect its interests, the company will begin staking and recording mining claims. These actions do not disturb the surface or require surface reclamation and would be considered casual use.

Prospecting and Exploration. Americans generally use the terms *prospecting* and *exploration* interchangeably. Prospecting normally denotes activities of a single person, whereas a company engages in exploration using a variety of techniques to evaluate both the surface and subsurface geologic characteristics of a mineral occurrence (Hartman 1992).

When a sufficiently anomalous mineral occurrence or favorable occurrence indicator is found, a mineral prospect is established and is subjected to more intense evaluation through exploration. This area may range from a single square mile to an entire mountain range of several hundred square miles.

Mineral exploration has had many cyclic developments in the last half century. Early efforts concentrated on comparing new areas with existing mines and mineralization. The introduction of airborne and satellite remote sensing, computer models, and a better understanding of geologic processes led to the discovery of porphyry copper deposits, Mississippi Valley lead-zinc deposits, and volcano genic massive sulfide deposits. In the past 15 years exploration has mainly targeted disseminated gold and stratiform precious metal deposits. In the future major exploration targets will focus on the following:

- World-class deposits of all kinds of minerals.
- Small high-grade deposits with low capital costs that will be profitable under any market condition.
- Polymetallic deposits that can be mined by surface methods (Hartman 1992).

Efforts to locate a mineral prospect include detailed mapping, sampling, and geochemical and geophysical study programs. At this time the mining company usually begins to acquire property, and most mining claims are located to secure ground while trying to make a mineral discovery. Surface-disturbing activities in prospecting involve more intense soil and rock chip sampling using mostly hand tools, frequent off-road vehicle use, and the placing and maintaining mining claim monuments. This activity is normally considered “casual use” (43 CFR 3809.1-2) and does not require BLM notification or approval. Operations under casual use require no mechanized equipment or explosives but must reclaim disturbed areas.

Exploration involves prospecting at a more intense level and in a smaller area. In addition, roads are built, trenches dug, and exploration holes drilled. In later stages of exploration an exploratory adit or shaft may be driven. If the prospect already has underground workings, these may be sampled, drilled, or extended. Subsurface exploration by shafts and large-diameter (more than 18 inches) drill holes are normally used for finding mineral targets or the development phase of mining and not initial exploration.

Exploration may involve mechanized earth moving equipment and drill rigs and explosives. A typical exploration project requires building about 5,000 feet of access road, setting up a dozen drill sites with each site having several holes drilled to less than 500 feet, and possibly digging several trenches 200 feet long by 8 feet wide by 6 to 8 feet deep. The number of pits and trenches depends on the expected size of the mineralized area as determined by surface mapping and sampling. Test pits are usually less than 20 feet deep and 10 feet in diameter. Trenches are normally less than 10 feet wide, 20 feet deep, and 100 feet long. The area for a drill rig is about 50 feet square. Most surface disturbed for exploration amounts to less than 5 acres. Exploration is normally conducted under a Notice in the existing 3809 regulations, which require the operator to notify BLM 15 days before beginning activity. If exploration is conducted in sensitive areas or exceeds the 5-acre threshold, an approved Plan of Operations is required.

Mine Development. If exploration results show that an economically viable mineral deposit is present, on-the-ground activity will intensify to obtain detailed knowledge on reserves, possible mining methods, and mineral processing requirements. This effort will involve more intensely applying all the previously used exploration tools. After acquiring enough information, the operator will conduct a feasibility study to decide whether to proceed with mine development and what mining and ore processing methods to use.

When an operator decides to develop a property, the mine permitting process begins. Once BLM approves the Plan of Operations, work begins on developing the mine infrastructure:

- Building the mill, offices, and laboratory.
- Driving development workings for an underground mine or prestripping for an open pit mine.
- Building access roads or haulage routes.
- Placing utility services.

During this development, exploration continues in order to define other areas to be mined.

Mine development involves the following activities: mining, ore processing, tailings disposal, waste rock placement, solution processing, and metal refining. Such activities require the use of

- Heavy earth moving equipment.
- Explosives for mining.
- Materials handling.
- Exploration equipment for refining the ore reserve base.
- Hazardous or dangerous reagents for processing requirements.
- General construction.

Once enough facilities are in place, mine production begins. Often concurrent with production are “satellite” exploration efforts to expand the mine’s reserve base and extend the project life. Upon completion of or concurrent with mining the property is reclaimed.

The sizes of mines vary greatly. Not all mines require all the previously mentioned facilities and equipment. Acreages involved can range from several single acres to several hundred acres. Most projects disturb more than 5 acres and require an approved Plan of Operations.

Mining Methods

The impact of mining and the effects of regulations on the mining industry depend on the mining methods used and the mineral deposits mined. Mining methods have been classified to help select extraction methods for deposit types and for other factors. In addition, this classification helps evaluate the impacts of the chosen method. Mineral deposits have been geometrically described by an idealized shape, inclination, size, and depth. Complex or composite bodies consist of more than a single deposit type (Hartman 1992).

The ideal shapes are either tabular or massive with narrow bodies or pipes being subordinate. Tabular bodies of minerals usually extend hundreds of feet horizontally and only a few tens of feet vertically. Ore from tabular bodies is generally extracted by strip mining, of which placer mining is a subcategory. Massive ore bodies are approximately equip-dimensional (laid out for easy equipment use) and are usually a few hundred feet in each dimension. Ore from massive bodies is generally extracted by open pit mining (Hartman 1992).

In surface mining the horizontal angle of the deposit (usually a bedded deposit with overburden less than 100 feet thick) and the deposit's relative width determine whether the minerals are mined by strip or pit methods. For example, flat-lying deposits are opened up by making narrow mining cuts into the deposit and then casting or hauling the next cut's waste into the previously mined area. Placer mining methods are used for deposits that are under water or have a large amount of ground water because of the need to handle large amounts of water. For deposits lying at a steeper angle or with thick overburden, open pit methods are used. The stability of the unmined rock determines the pit's depth.

Strip Mining. Strip mines have the following characteristics:

- Usually designed for rectangular tabular deposits that are longer than they are wide.
- Found in areas of rugged topography where the deposit may be bisected by narrow gullies.
- Located where the overburden is relatively shallow (low stripping ratios) and the deposit itself is not at a great depth below the land surface.
- Used where the deposit is interbedded between uneconomic rock units or located in topographic low areas (valleys).

In strip mining the topsoil and overburden are removed from the ore deposit and stockpiled separately, usually a short distance from the initial mine cut. The deposit is mined in a linear fashion until the end of the ore deposit or the property limits are reached. A second identical pass is then made next to the first except that the overburden is placed into the previous mined out area. After the third cut is made, the original stockpiled overburden is graded into and over the first two cuts. Topsoil is then respread over the site, and vegetation is reestablished. The remaining deposit is mined in a similar fashion until the deposit is exhausted. The strip mine is reclaimed at the same time that ore is mined, except for the last one or two mine cuts, which are reclaimed after the mine is closed.

In strip mining little more area is disturbed for waste rock or tailings dumps because these materials are returned to the mined area as soon as there is space. Access roads, mill and office buildings, and water treatment facilities usually occupy the only other areas needed for this type of mining.

___**Placer Mining.** Suction or mechanical dredge mining techniques are commonly employed to extract minerals lying in loosely consolidated deposits with large amounts of ground water or in rivers or lakes. Intake nozzles for suction dredges vary from 2 to 10 inches in diameter. The most common sizes range from 4 to 6 inches. Generally the processing system is relatively simple with a grizzly (screen) separating off the oversized rocks. Screens classify the smaller material and a sluice box, with regular or modified iron angle-iron riffles, concentrates the valuable minerals. The recovery system is usually supported on floats above the intake nozzle in the pond that is created when excavating the overburden. A gasoline-powered high-pressure water pump supplies water to the intake for suction to extract the mineral-bearing material from the pay streaks or bedrock areas.

In the past, mechanical bucket-line dredges were used to mine deeply buried placer minerals. These dredges moved great amounts of material while floating in a pond created by the excavation of the barren gravels. Material was excavated and processed on and tailings were disposed from the floating platform. The moving chain of buckets excavated the gravel. Gravels were emptied into revolving screen classifiers, which separated the undersized material from the oversized. The oversized material was transported by conveyors behind and away from the dredge.

The processing plant for the recovery of the gold consisted of either jigs or sluice boxes onboard the dredge. Most of these dredges are no longer operating on public lands. Smaller cutter-head dredges can be used. But because of high mechanical wear and many breakdowns, other mining methods are more commonly used to mine alluvial deposits.

Placer deposits are mined either by strip or pit methods with the addition of water control structures such as bypasses or drains to dewater the gravel deposits. Once the water has either been removed or reduced to an amount manageable through the use of pumps, the topsoil is removed and saved for future respreading over the mined areas. The overburden is removed and stockpiled or placed in previously excavated areas as part of the reclamation sequence of the mine. The mineral-bearing gravels are hauled to the processing or washplant, where gravity separation methods are used to recover valuable minerals in the sluice box or jig unit. The washed gravels are placed in the previously mined areas, usually on top or intermixed with the overburden. The tailings are then reshaped, covered with the original topsoil, and reseeded to prevent erosion and finish the reclamation of the mined site.

Open Pit Mining. Open pit mines have the following characteristics:

- Usually designed for massive or steeply inclined (dipping) deposits.
- Dimensional or narrow in extent and size.
- Found in areas of rugged topography.
- Located where the overburden is relatively thick (high stripping ratios).
- Located where the deposit is relatively deep below the land surface.
- Used where the deposit is interbedded between uneconomic rock units or where the rock

strength is weak and not suitable for underground methods.

The topsoil and overburden are removed from the ore deposit, and the deposit is mined in a downward fashion until the limits of the deposit are reached. The limits of the mine pit are not solely related to the grade of the ore but also to the engineering of the pit slopes and the economics of removing overburden and ore from the pit.

The stockpiled overburden is placed in valleys near the mine site or on the surface of adjacent land and then graded into a stable shape. The waste rock from the mill is deposited in large settling ponds or may be placed on the surface of the land and reshaped. Ponds are located where they are most cost effective and the topography is most stable. The land beneath the ponds and waste piles is permanently lost to any other uses. Topsoil is placed over the overburden or waste piles and the pond areas when they are reclaimed, and vegetation is established at the sites.

Reclamation is generally not concurrent with mining and is not usually begun until the mine is closed. If the mine is deep, the cut is generally not filled. In open pit mining other areas are disturbed for waste rock and tailings dumps, access roads, mill and office buildings, and water treatment facilities.

Underground Mining. Underground mining generally involves the removal of the mineralized vein or lode from the surrounding country rock. Minable widths vary from less than 4 feet to more than 20 feet. Ore is usually extracted from highly competent rock or rock that is reinforced with bolts or anchors so that surface subsidence is negligible. Massive block caving techniques may create localized subsidence of the surface. The mined-out underground workings are usually backfilled with the waste rock from mining or the mill tailings. Backfilling maintains the competency of the surrounding rock and prevents subsidence.

In all underground mining some of the waste must be placed on the surface temporarily or until there are enough underground openings to hold the replaced waste rock. Some waste rock may be placed on the surface permanently because there is not enough room to replace the waste or the mining method is not amenable to replacing the waste.

Most surface impacts from underground mining involve mining-related surface uses such as milling, office functions, storage, waste and tailings disposal, and water treatment. All of these activities are similar if not the same as the surface-disturbing activities of surface mines and mill sites.

In Situ Mining. A mining method that is considered neither surface nor underground is “in situ” extraction of valuable minerals by remobilizing or leaching minerals where they occur. This method drills holes on a grid pattern into the ore deposit. A dissolving or leaching solution is then injected through these holes into the ore deposit, where the chemicals extract the desired minerals. The pregnant liquid is then removed from a different well or series of wells and piped to a recovery plant or mill. There the minerals are recovered and the barren solution returned to the injection wells and the cycle begins again. In situ mining appears to be more like a milling operation and less like most extraction methods. Except for the access roads and pipelines leading to the recovery facility, the surface is only slightly disturbed.

Mill Sites and Tailings Sites. Mill and tailings sites are usually found with one of the other types of mining methods, depending on the characteristics of the ore. At mills, minerals can be extracted either by chemical or physical methods. Mill sites can also be established apart from any specific mine and operate as a small custom mill for small operators.

Storage facilities and mills for processing mined rock and treating tailings have traditionally been placed on areas that have no mineral value. These sites may be next to the mine or removed some distance from the mine site.

Mill sites are used for locating offices, warehouses, repair shops, crushing and grinding systems, chemical and physical separation and concentration systems, leach pads, and other facilities that support the mine. Mill processing plants may be as simple as a sluice box next to a water source and the alluvial material trucked to the site. Or they may consist of a group of structures, each housing a part of the processing machinery that recovers the commodities in a series of steps. Milling of certain ores ranges from simple gravity and water washing systems to chemical and flotation treatments to mechanical crushing and sorting processes that form the finished product. Mill facilities may cover an area from less than 1 acre to 10 or more acres.

Since the 1980s tailings impoundments have become a small part of the mill site operations, as more mines used cyanide heap leaching techniques to recover the minerals and only small treatment and concentration buildings are needed for mills. Some heap leach pads are massive–2,000 feet wide by 2 miles long–and are in continuous use for up to 5 years.

Tailings disposal is a major if not sole purpose of some mill site claims. Tailings is the general term for all waste rock and processed rock that remains on the surface after the valuable minerals have been extracted. Some waste rock is barren of mineralization and may cause no problems being left on the surface after reshaping and the establishing of vegetation cover. But other waste rock has minerals with the potential to generate acid or alkaline leachate and may affect the environment for many years.

Tailings have undergone physical and in some cases chemical changes and may have been ground so fine that they are more susceptible to erosion or chemical changes than in their original state. Or residual traces of treatment chemicals may be trapped in the rock. In general, tailings and waste areas occupy about 10% of the total area disturbed by mining.

Mill sites may require either a Notice or a Plan of Operations, depending on whether they are in designated special status areas or if they exceed 5 acres.

Types of Operators

A wide variety of mineral exploration and extraction occur on public land. Operations range from the lone prospector to corporate-driven enterprises. Operators have varied range of financing, expertise, resources, and abilities to develop mineral deposits. On the average all types of mineral operators have strong land stewardship and understand the need for a good environment.

The lone prospector is working on locating that mother lode deposit that they can sell or lease to bigger operation to continue exploration or development of the mine. Small independent geologist and exploration companies are also trying to locate and define potential ore deposits that they can sell to even larger operations in order to develop. These types of operations are stacking capital, time, and labor into these projects in the hopes that in selling them they make a profit.

Mining also has small operators. These operators consist of small families who work mining operations and whose wages consist of profits above the capital costs from their operations. Small operators work in the belief that time will make their efforts highly profitable.

In addition, some people explore and mine for the enjoyment of the activity. These people and groups are engaging in a recreational past time. Developing minerals and earning profits from the activity are only secondary to the activity itself.

And there are some operators whose intent is not to develop minerals. They derive their profits from investments received from others. They develop operations and sell shares of it, hoping to make a profit on the operations. Though few, these operations do occur on public lands.

Operations backed by corporate resources has extensive abilities to explore and develop mineral properties. These companies usually have strong environmental policies and the ability to accomplish the needed tasks. Their overriding goal, however, is to make a profit.

Past Activity Under the 43 CFR 3809 Regulations

BLM issued the 3809 regulations in 1981. The following information on past mining on the public lands was developed from *Public Land Statistics* (BLM various years) and internal BLM surveys.

Between 1981 and 1997 a total of 20,700 Notices and 3,400 Plans of Operations were submitted to BLM. An average of 1,200 Notices and 200 Plans of Operations have been submitted each year. But the number of operations has been decreasing over the last several years. In 1999 BLM received 155 Plans and 640 Notices. As of 1997, a total of 6,216 Notices and 932 Plans of Operations were considered active (see Tables 3-2 and 3-3), meaning that operations under the Notices or Plans were ongoing. The remainder had been reclaimed, and BLM had determined that they were closed. A total of 177 and 155 Plans of Operations and 588 and 640 Notices were submitted in 1998 and 1999 respectively according to *Public Land Statistics* (BLM 1999a, 2000a). The number of operations that have closed in the past 2 years is unavailable.

Table 3-2. Notice-Level Activity

Type of Activity	Submitted Since 1981		Closed Since 1981		Currently Active	
	# Notices	Acres	# Notices	Acres	# Notices	Acres

Exploration	13,653	27,463	9,767	18,433	3,915	9,555
Strip Mining	257	738	155	460	102	278
Open Pit	999	2,071	453	1,022	556	1,048
Placer	5,012	12,133	3,382	8,670	1,317	3,472
Independent Mill Site	135	402	65	193	66	200
Underground	644	1,101	386	678	260	436
Total	20,700	43,908	14,208	12,866	6,216	14,989

Table 3-3. Plan-Level Activity

Type of Activity	Submitted Since 1981		Closed Since 1981		Currently Active	
	# Plans	Acres	# Plans	Acres	# Plans	Acres
Exploration	1,302	18,742	1,032	5,415	269	13,422
Strip Mining	87	13,123	66	8,332	22	4,790
Open Pit	591	117,166	261	14,563	330	101,564
Placer	1,288	7,993	949	6,269	232	1,724
Independent Mill Site	52	6,281	18	104	33	6,182
Underground	85	6,514	39	399	46	6,115
Total	3,405	169,819	2,365	35,082	932	133,797

Tables 3-4 and 3-5 show the distribution of current mineral activity by state and the types of activity currently occurring on public lands in the study area.

Table 3-4. Percentage Distribution of 1997 Notices and Plans by Type of Activity

Type of Operations	Notices	Plans
Exploration	63	29
Strip Mining	2	2
Open Pit Mining	9	35
Placer Mining	21	25
Underground Mining	4	4
Independent Mill Site	1	5
Total	100%	100%

Table 3-5. Total 1997 Plans and Notices in Study Area				
State	Total Notices	% of Total Notices	Total Plans	% of Total Plans
Alaska	153	2	47	5
Arizona	909	15	96	10
California	1,009	16	290	31
Colorado	264	4	23	2
Idaho	135	2	35	4
Montana	300	5	27	3
Nevada	2408	39	277	30
New Mexico	68	1	6	1
Oregon/WA	386	6	38	4
Utah	410	7	39	4
Wyoming	174	3	54	6
Total	6,216	100	932	100

The surface disturbance varies for each type of operation from an average of 300 acres of disturbance for open pit mines to 7.4 acres for placer mines. Disturbance for Notice-level exploration operations ranges from 0.5 to 4 acres. Tables 3-2 and 3-3 show the estimated average number of acres disturbed by Notice- and Plan-level operations on public lands. The Notices and Plans closed means that reclamation has been completed and accepted by BLM. Current active operation may have the operation and reclamation completed but are still waiting for final reclamation clearance.

Table 3-6 shows the number of notices of noncompliance that have been issued on public lands and the reasons they were issued.

Table 3-6. Notices of Noncompliance				
Type of Activity	**Notice-Level Operations**		**Plan-Level Operations**	
	# Issued Since 1981	**# Currently Outstanding**	**# Issued Since 1981**	**# Currently Outstanding**
Exploration	384	138	79	14
Strip Mining	7	0	4	2
Open Pit Mining	88	9	66	10
Placer Mining	145	24	70	9
Independent Mill Site	26	6	26	8
Underground Mining	40	4	13	3
TOTAL	690	181	258	46
Currently Outstanding Notices of Noncompliance				
Reason for Issuance			Notice Level	Plan Level
Failure to file a Notice or Plan			13%	19%
Issued during operational phase of project			15%	35%
Failure to reclaim			72%	46%
Total			100%	100%

BLM issues notices of noncompliance only when operators fail to correct or discuss concerns. BLM will work with operators during compliance inspections and meetings before issuing notices of noncompliance. Under the current policy BLM will meet or inform the operator of a concern and work with the operator to remedy the concern to both BLM and the operator's satisfaction. Only when the operator refuses to address the concern with BLM do the noncompliance procedures begin with the issuing of a notice of noncompliance.

The existing regulations call for three levels or procedures for incidents of noncompliance. At the first level, BLM issues a notice of noncompliance requiring operators to correct problems by a certain date. At the second level, if operators do not correct the noncompliance, BLM issues a record of noncompliance, and operators must post bond for their entire operations at 100% of reclamation costs. And at the third level, if operators take no further action, BLM sends their cases to the U.S. Attorney's Office to be resolved. Of the total incidents of noncompliance 76% have been resolved by notices of noncompliance, 15% by records of noncompliance, and 9% by the U.S. Attorney.

Historically, the number of noncompliance issues have been small, amounting to about 4%, of the number of Notices and Plans submitted. These noncompliance issues have involved unnecessary or undue degradation to public lands, mainly reclamation not being completed. Conditions in these unreclaimed areas have degraded public lands and to various degrees are continuing to degrade public lands.

Of the 254 active notices of noncompliance, 208 are for Notice-level operations, and 46 are for Plan-level operations. BLM has issued notices of noncompliance to 3% of Notice-level operations and 4% of Plan-level operations; 73% of all notices of noncompliance issued have been resolved.

Environmental Consequences

Impacts Common to All Alternatives

Under all alternatives compliance with environmental regulations represents a cost to the mining industry and affects the level of mineral exploration and mining. Included are the following costs:

- Costs of delays resulting from longer processing times.
- Direct costs of conducting environmental studies.
- Costs of having to use certain technology.

Delays could result from an operation's not being able to mobilize on schedule because of weather and other restrictions. Delays could mean that a deposit would not be developed, production would not begin on schedule, and the operation would lose revenue. Environmental standards also increase the cost of doing business.

These regulations and the expanded regulatory environment have had a cumulative effect on the mining industry's cost of doing business. The new state and federal regulations are requiring more time and monitoring from the operator to meet these new requirements. These types of activities relate to operations in cost. These costs range from less than 1% of the total cost of the operations to as high as 20% of the overall operating budget. These cost vary greatly depending on an operation's site-specific resource concerns.

The mining industry will continue to experience increased regulations and restrictions from state and federal agencies. Mandates such as the toxic release inventory will continue to require more reporting and monitoring of operations. Several sweeping regulatory changes to the Clean Water Act (CWA) programs are pending, and proposed and final test method changes show the breadth of changes to the CWA programs. The Departments of the Interior, Agriculture, Commerce, Defense, and Energy; the Environmental Protection Agency; the Tennessee Valley Authority; and the Army Corps of Engineers have also just developed a federal lands policy drafted to purportedly enhance implementing the Clean Water Act and the Administration's Clean Water Action Plan. Land use restrictions from zoning and mineral withdrawals will continue to restrict access to areas for mineral development. The changing agency policies, responding to environmental degradation, political pressures, and court cases, will change how the mining industry operates on public lands.

Alternative 1: No Action

Administration of Surface Management Regulations. Under the No Action Alternative the mining industry would continue to operate under the existing 3809 regulations and would continue to assimilate the cost of the regulations. Operations would continue to be processed, and compliance would be completed. These regulations would result in no added cost to industry.

Casual Use. Casual use should only negligibly disturb the environment. But major problems could arise when groups get together to recreate, explore for minerals, or placer mine for gold. Under these situations the cumulative impacts could exceed negligible levels, resources would be damaged, and the disturbance would generally not be reclaimed.

For example, several dozen to more than 100 people equipped with shovels and gold pans in a small area or section of stream can denude the vegetation, compact the soil, and result in a loss of deeper rooted vegetation. This disturbance could lead to streambank destabilization, resulting in a series of channel adjustments over a broader area. Such changes in turn this could lead to the loss of riparian areas.

Notices. The existing regulations for Notices would require BLM to process actions in a short time period and allow operators to continue operations without delay. An interdisciplinary team would review Notices, but the review would be limited to 15 days. In some situations the review specialist could not review the document, and the project would proceed without this specialist's input. Under these conditions resource damage could result.

A Notice could be used to operate in an environmentally sensitive area because the existing regulations list only a few areas that are environmentally sensitive and thus require a Plan of Operations. Any operations that are in sensitive areas but do not require Plans of Operations would increase the potential for degradation without the intense review provided for Plans.

Notice provisions could be difficult to enforce because no reclamation bond is required for Notice-level activity. The lack of a bond and enforcement process could result in areas not being reclaimed when operators leave, although this is not a common practice. BLM issued about 500 notices of noncompliance (out of about 29,400 Notices filed since 1981) for failure to reclaim, representing 2% of all Notices submitted.

Plans of Operations. Under No Action, BLM would continue to review in detail Plans of Operations, and these Plans would undergo environmental review under the National Environmental Policy Act (NEPA). NEPA's analysis would allow for a more detailed review of operations and would ensure against unnecessary or undue degradation.

Policy would require reclamation bonding for all chemical processing areas, but only a portion of the reclamation cost would be bonded for other facilities. BLM field offices might not uniformly implement bonds and other performance measures that BLM has developed by policy and experience.

The current gold prices have affected the industry, and mining companies are going into bankruptcy and increasing BLM workloads. Workloads have increased as BLM tries to use the bond monies available and to acquire public monies to clean up these operations. On the basis of past bonding practices, the bond amounts are not adequate to completely reclaim the operations. In Nevada alone, 29 operations are in bankruptcy.

Inspection and Enforcement. The existing regulations make timely resolving of noncompliance difficult and do not outline the need for consistent review of operations. As a result, BLM might not inspect operations in a timely manner, and resource degradation could result.

Under the current process if an operation is in noncompliance, BLM would need more time for coordination with the operator and other organizations to resolve the noncompliance. If the operation does not conform to the Plan or Notice, BLM would issue a notice of noncompliance and request compliance within a certain time. If the operator still does not comply, the operation's file would be sent to the BLM state office for transmittal to the U.S. Attorney's Office. Because of the U.S. Attorney's workload and priorities, years could pass before the case could be settled and the environmental problem corrected.

If the operation is abandoned and the case is not settled in the courts, there might be no bond to reclaim the operation and resolve all environmental concerns. The site would either not be reclaimed, or public monies would be used to reclaim it. In 1999 BLM surveyed its field offices, asking them to list all operations under the existing 3809 regulations that had been abandoned by their operators, and where BLM had spent, or was likely going to have to spend, funds to reclaim the land. The combined field office response listed some 530 such operations. The actual number of abandonments is even greater since not all abandoned operations will require remediation. Most of these are abandoned Notice-level operations. The amount of public monies needed to reclaim these sites is unknown at this time.

Data from the recent past suggests that if the current rate of noncompliance persists, within the next 20 years BLM would issue 360 notices of noncompliance for Notice-level activity and 120 for Plan-level activity.

Administrative Practices. Under the existing regulations, mines proposed either for areas withdrawn from mineral entry or for extracting suspected common variety minerals under the Mineral Materials Act of 1947 and the 1955 Surface Resources Act would be processed under a Notice or a Plan of Operations. The operator would not have to demonstrate a valid claim before disturbing the surface. Potential environmental harm could result, and the Federal Government could lose revenue.

Mineral Development. The overall number of Notices and Plans of Operations submitted under No Action is expected to decrease to the current 3-year trend and remain constant or decrease slightly. This trend is based on the existing regulations and the current regulatory environment for operations on public lands. Individual states might vary from the general trend in the number of Notices and Plans submitted. For this analysis, 600 Notices and 150 Plans of Operations would be submitted each year. Over a 20-year period 12,000 Notices and 3,000 Plans of Operations would be submitted. Table 3-7 shows the acreage that would be disturbed per operation and total acres that would be disturbed in 20 years under the No Action Alternative.

Table 3-7. Acres Disturbed under Alternative 1			
	Acres Disturbed		
	Per Operation	**Per Year**	**In 20 Years**
Notice Level	2 acres	1,200	24,000
Plan Level	50 acres	7,500	150,000

Table 3-8 shows the possible number of operations at the Notice and Plan levels by operation type during the next 20 years.

Table 3-8. Notice- and Plan-Level Operations over a 20-Year Period under Alternative 1		
Type of Operation	**Notices**	**Plans**
Exploration	7,560	870
Strip	240	60
Open Pit	1,080	1,050
Placer	2,520	750
Underground	120	150
Mill Site	480	120
Total	12,000	3,000

Exploration. Exploration activities would continue to be processed on the basis of the type of operation and the amount of surface disturbance. There would continue to be a short turnaround for operations working under Notices, and the industry should incur no more cost. Small independent geologists and prospectors would continue to pursue mineral deposits as allowed under the existing regulations. Most small operations and individuals mining for recreation would be considered casual use.

Mining**.** Mining operations would continue under the existing regulations and policies, which include the cyanide management and acid rock drainage policies. Future policies could be developed to define environmental protection requirements under the existing regulations.

Alternative 2: State Management

Administration of Surface Management Regulations. State mining regulations are relatively new and still evolving. The main regulatory provisions in most cases are less than 8 years old, and many are newer (McElfish and others 1996). State programs are based either on requiring reclamation or preventing water pollution (or both). (See Appendix D.)

Casual Use. Under the State Management Alternative state government would not review proposed mineral activities classified as casual use. Depending on the state requirements and minimum surface disturbance criteria, the mineral activity might not be reviewed. States would not require casual use operations to complete reclamation, and public lands could undergo unnecessary or undue degradation. BLM would have difficulty directly preventing degradation except through negotiations with state organizations.

Notices. For Notice-level operations, depending on state requirements, operators may not be required to submit any documentation for review by a state organization. In some states, operations smaller than 5 acres are not required to be reclaimed. Such operations would still be required to meet state environmental protection and performance standards.

Plans of Operations. Under State Management, depending on state criteria for surface disturbance or production, operations would be required to submit some form of a Plan of Operations to a state regulatory agency. The operation would have to meet performance standards and requirements of the state in which it is operating. Western states have environmental regulations that require some of the reviews outlined in BLM's existing regulations. Some states would require environmental reviews. Others would not. Operations would have to comply with water regulations and standards and monitoring outlined by the states. Bonding would also be required. Depending on the state program, bond monies may or may not be sufficient to reclaim the operations.

Inspection and Enforcement. Operations would have to undergo compliance inspections, but depending on the state organizations, standards or schedules might not be established. BLM would not issue notices of noncompliance under Alternative 2 and would not take be directly involved in enforcement actions. States would continue to enforce their own programs. (See Appendix D.)

Mineral Development. According to the mineral activity projections in Appendix E, the overall range of change under State Management would be from a 0% to 5% increase in exploration and mining activity. (See Appendix E.) These changes, by activity type, are shown in Table 3-9.

Table 3-9. Changes in Mineral Activity under Alternative 2

Casual Use/ Suction Dredging	Small Exploration	Large Exploration	Small Placer	Large Placer	Small Open Pit	Large Open Pit	Small Underground	Large Underground	Industrial Minerals
0 - +5%	0 -+5%	0 - +5%	0 - +5%	0 - +5%	0 - +5%	0 - +5%	0 - +5%	0 - +5%	0 - +5%

Table 3-10 outlines the possible number of operations by type under the State Management Alternative for the next 20 years.

Table 3-10. Number of Operations under Alternative 2 over a 20-year Period

Type of Operation	<5 acres	>5 acres

Exploration	7,560	7,940	870	910
Placer	2,520	2,650	750	790
Strip	240	250	60	70
Open Pit	1,080	1,130	1,050	1,100
Underground	120	130	150	160
Mill Site	480	500	120	130
Total	12,000	12,600	3,000	3,160

Under these assumptions, on the high end, 630 operations would disturb less than 5 acres a year, and 160 operations that would disturb more than 5 acres a year. Over a 20-year period, from 12,000 to 12,600 operations would disturb less than 5 acres each, and from 3,000 to 3,160 operations would disturb more than 5 acres each. Table 3-11 shows estimated acreage that would be disturbed under Alternative 2.

Table 3-11. Acres Disturbed under Alternative 2					
	Acres Disturbed				
	Per Operation	**Per Year (0 - 5%)**		**In 20 Years (0 - 5%)**	
Notice Level	2	1,200	1,260	24,000	25,200
Plan Level	50	7,500	8,000	150,000	158,000

Exploration. Depending on a state's regulations, potential exploration would increase because operations may not have to submit notifications to either BLM or some state agencies. The higher end of the range would be in states that do not require notification or the operator to spend extra capital and operational cost to cover exploration permitting. The smaller exploration companies, independent geologists, and prospectors could earn more profits in future property sales. The percentage of increase would depend on the state regulations that would need to be followed. Operations at the lower end of the range would be regulated by states with more restrictive regulations. Operations of all sizes should see a decrease in permitting costs.

Mining. The range of change would be small for mines operating in states that have mining and reclamation regulations. The major change would be the amount of environmental work required from each state. Mines in states requiring environmental analysis documents similar to EAs and EISs, and plans with bonds would not experience any change. States not requiring environmental documents would see an increase in mining in response to a decrease in the cost of exploration in these areas. Operations of all sizes would see some decrease in the amount of permitting required to open a mine.

Alternative 3: Proposed Action

Administration of Surface Management Regulations. The proposed regulations would increase costs to the mining industry.

Casual Use. Casual use would continue to consist of operations that cause negligible disturbance. People and organizations that are now conducting operations as casual use would continue to engage in exploration and mining for recreation and mineral development but could not cause surface disturbance above the definition of casual use without a Notice or Plan. The resulting decrease in cumulative impacts of casual use would improve environmental protection.

BLM would be able to determine if many operations whose cumulative effects are causing degradation beyond casual use would require a Notice or a Plan of Operations. Preparing Plans or Notices would delay activities and affect small recreational activities. In responding to the submittal of Plans and Notices and providing timely response to recreational activities, BLM's workload would increase.

Notices. Under the Proposed Action exploration involving less than 5 acres could operated occur under a Notice. Any mining in special category lands would require Plans of Operations. Under Notices, operators would be subject to performance standards that would minimize impacts to ensure against unnecessary or undue surface degradation. These standards would require the operator to design activities and take more time in developing operations. More time by BLM and the operator would be required to address the performance standards and determine the site-specific needs for the projects. This would increase costs for industry and the workload for BLM.

The Proposed Action would require bonding for Notice-level operations. Reviewing and accepting a bond would require more work for BLM but would provide a way to enforce reclamation and mitigation. The cost of obtaining a bond, where one was not previously required, would be a considerable added expense to exploration operators.

Plans of Operations. Plans of Operations would be expanded to include all types and sizes of mining operations. Exploration projects that disturb more than 5 acres or are in special category areas would also require Plans of Operations. BLM's workload would increase with all mining operations being required to submit Plans of Operations.

BLM workload would increase with the need to review or coordinate several activities before approving a Plan. These activities would includes a 30-day public comment period in conjunction with the environmental analysis and consultation with other interested parties and agencies.

Environmental performance standards under the Proposed Action are similar to current BLM polices and guidelines in various states. BLM has developed policies on certain issues, such as cyanide management, through experience in working with the mining industry and the public. BLM has also applied its understanding of what actions or data are needed to prevent unnecessary or undue degradation. The Proposed Action has incorporated these policy standards into the regulations. No other impacts to industry or natural resources are expected from these standards other than greater consistency among BLM offices.

Plans of Operations would require bonding for 100% of the estimated reclamation cost, increasing workloads by requiring BLM to review in more detail the reclamation plan and cost estimating. Bonding would result in a more a complete interdisciplinary review of the reclamation plan and assure the reclamation of disturbed land if the operator cannot meet their reclamation responsibilities. Mining companies would face more delays in starting or modifying their projects. Funds for reclamation in the event of operator bankruptcy should be adequate to reclaim the operations.

BLM might disapprove a plan if it does not meet the requirements of the regulations, the exploration or mining site lies within an area withdrawn from mineral entry, or the activity would result in unnecessary or undue degradation. This would be a significant impact on the operator and mineral resource development.

Inspection and Enforcement. The Proposed Action would require a mandatory number of inspections for certain types of operations. The specific inspection frequency is already included in BLM policies and is not expected to increase BLM workloads.

Enforcement provisions of the Proposed Action would include the use of suspension orders and discretionary penalties, which BLM could assign for noncompliance. These orders and penalties would slightly increase the workload to develop the case and defend the orders and penalties. But BLM would have greater legal recourse to use against operators who refuse to comply.

Under the Proposed Action during a 20-year period 200 to 180 notices of noncompliance and suspension orders could be expected for Notice-level activity, and 260 to 230 could be expected for Plan-level activity.

Administration Practices. The Proposed Action would change the regulations to include Stock Raising Homestead Act lands whose surface is privately owned but whose mineral estate has been retained by the Federal Government. These new regulations would allow access to those lands for mineral resources but would apply only if the land owner and the mineral operator cannot agree on the development of the minerals. BLM’s workload would increase with the development of Plans of Operations, but the number of Plans that would be submitted is uncertain. BLM’s workload, however, would increase under all alternatives because recent amendments to the Stock Raising Homestead Act mandate BLM’s involvement whenever the surface owner does not consent to mineral development.

The Proposed Action would require a mineral validity exam for any operation in an area under mineral withdrawal. Before BLM can allow operations to start, the exam must show that the operator has the right under the Mining Law to disturb surface resources. By not being allowed to begin operations until the exam has been completed, an operator could lose revenue due to time delays. Conversely, if the operator does not have the right to develop the minerals, then the environmental resources would be protected. BLM’s workload would increase because of the exam requirement. The validity exam is an extensive process that BLM-certified mineral examiners can complete.

Under the Proposed Action, if a mineral is suspected of being of common variety, the operator might receive an interim authorization until a validity exam is conducted with a common variety determination. During the interim authorization, operators could continue to sample their site and conduct yearly assessment work to meet Mining Law requirements and hold their claims. Or they could develop an escrow account in a form acceptable to BLM.

Developing an escrow account and depositing the fair market value of the material mined would allow operators to continue mining until the common variety determination has been completed. If the mineral is determined to be uncommon, the money would be refunded to the operator, who could proceed under the Mining Law. If the mineral is determined to be common and salable under 43 CFR 3600, the money would be paid to the U.S. Treasury.

These regulations would increase BLM's workload by requiring BLM to review the proposals and determine if impacts have been minimized. BLM would also have to review operations to ensure that they have met the standards outlined in the regulations and determine if the impacts would be at the lowest practicable level. Under its current funding and staffing levels, BLM's increased workload would delay projects, and BLM might not be able to meet the 30 working day response time for Plans of Operations.

Mineral Development. Implementing the Proposed Action is projected to decrease mineral activity across the study area. These changes by operation type for the Proposed Action are shown in Table 3-12.

Table 3-12. Changes in Mineral Activity under Alternative 3

Casual Use/ Suction Dredging	Small Exploration	Large Exploration	Small Placer	Large Placer	Small Open Pit	Large Open Pit	Small Underground	Large Underground	Industrial Minerals
-10 to - 25%	-10 to -20%	-10 to -20%	-10 to -20%	-5 to -15%	-10 to -30%	-10 to -30%	-10 to -20%	-5 to -15%	-5 to -15%

The largest potential decrease in mining could result because Plans of Operations would be required for many operations that under the existing regulations would need only a Notice. For all operations the requirement to avoid "significant irreparable harm" might delay or preclude operations. Although BLM is expected to invoke this standard rarely, the waiting and uncertainties of the requirement would reduce mineral activities.

Table 3-13 estimates the number of Notices and Plans that could be submitted over a 20-year period for different types of mining operations under the Proposed Action.

Table 3-13. Number of Mineral Operations under Alternative 3 over a 20-Year Period

Type of Operation	Notice-Level		Plan-Level	
Exploration	6,050	6,800	700	740

Placer	0	0	2,650	2,980
Strip	0	0	250	280
Open Pit	0	0	1,500	1,900
Underground	0	0	220	250
Mill Site	0	0	490	550
Total	6,050	6,800	5,810	6,700

From 300 to 340 Notices for exploration and from 290 to 330 Plans of Operations would be filed each year under the Proposed Action. Over a 20-year period, from 6,050 to 6,800 Notices and from 5,810 to 6,700 Plans of Operations would be filed.

Table 3-14 shows the average acreage that would be disturbed by Notice- and Plan-level operations under the Proposed Action. Disturbance for operations that the Proposed Action would upgrade from the Notice to the Plan level was calculated at 2 acres per operation.

Table 3-14. Acres Disturbed under Alternative 3					
	Acres Disturbed				
	Per Operation	**Per Year**		**In 20 Years**	
Notice Level	2	600	680	12,000	13,400
Plan Level	2-50	6,100	6,900	122,500	143,000

Casual Use/Suction Dredging. Use of suction dredges would require planning further in advance before engaging in the activity. This requirement could reduce the number of suction dredging operations or result in more unauthorized activity on public lands from these operators.

Exploration. Under the Proposed Action, exploration projects disturbing less than 5 acres would continue to submit a Notice to BLM. But Notice-level operations would require reclamation bonding at 100% of the cost of reclamation. This requirement would increase the costs of operations and could economically harm small independent geologists and prospectors, who might also have difficulty obtaining these bonds. The uncertainty of obtaining a bond would affect the entire range of mineral activity.

Mining. All mining would require Plans of Operations. Therefore, mining operations that previously had only to submit Notices would have to submit Plans of Operations. All small operations (only 5 to 10 persons) would now be required to prepare Plans of Operations and environmental documentation. The environmental requirements and the level of detail for any operation would be based on site-specific locations and the type of operation proposed. Many of the small operators could be hard pressed to post the bond for Plan-level operations and meet environmental requirements. The range of decrease in mineral activity (0 to -30%) would result from the uncertainty of obtaining the required data, the amount of data, and the detail of the data and the difficulty of obtaining a bond either through bonding companies or other methods.

Operators would have to post bond at 100% of the reclamation cost of operations. And bonds would be more difficult to obtain because corporate guarantees would not be allowed in future operations.

The requirement to avoid unnecessary or undue degradation could cause operators to question whether a mine can be developed. The potential use of the "significant irreparable harm" standard could significantly discourage the development of mineral properties. BLM is expected to use this standard only minimally to deny operations. But that all activity would have to meet the requirement could greatly increase mitigation costs and operator expenses to the point where some operations would no longer be economically feasible. In addition, applying (or not applying the significant irreparable harm standard is expected to be extensively litigated in the administrative and judicial systems. The uncertainty of development of mineral properties could make industry unwilling to take the financial risk, even for exploration. The uncertainty of the proposal is shown in the range of decrease in mineral activity

Alternative 4: Maximum Protection

Administration of Surface Management Regulations. The use of technical design standards might reduce the flexibility that operations have under the existing regulations and could reduce the level of exploration and mining. BLM would outline to the operator which technical standards to use. If the standards fail to protect the environment, the industry could argue that it would not have to take remedial actions because it has followed the standards and completed the process exactly as outlined. The mining industry could further argue that it is not liable for the damage because of the failure or inadequacies of the technical standard.

Casual Use. Casual use could continue once BLM has reviewed a proposal and determined that an action is casual use or that a Plan of Operations must be submitted. Operators would either have to write or visit BLM to determine if the operation consists of causal use. Having to review proposals and make these determinations would increase BLM's workload.

Notices. Alternative 4 would discontinue Notices, which would significantly affect exploration operators.

Plans of Operations. All actions that do not meet the casual use definition would require Plans of Operations. Operators would have to plan more time to develop mining actions so that BLM could process them. Exploration would have more scheduling problems because it is based on current information that is being developed for a potential target. During exploration, information could change and require operators to change their exploration plans. These changes could delay drilling and the overall operation because of the wait for additional approval. These delays could be costly in time and money. Developing Plans of Operations would be a complicated and time-consuming process.

Under Alternative 4, BLM could deny a mining permit under any of the following conditions:

- The operation could not prevent irreparable harm.
- Wetlands and wildlife habitat could not be reclaimed within 10 years.
- Water would have to be treated for more than 20 years after closure.

These determinations would be based on predictive models and professional opinion, and the predicted impact might or might not occur. These decisions would restrict the mining industry from accessing minerals on public lands.

Alternative 4 would further restrict mineral entry by requiring BLM to perform validity exams for all operations and for common/uncommon variety minerals. Before approving Plans of Operations for mining BLM would also have to develop a feasibility study for proposed mines to determine if mining would be feasible. Preparing these documents would be time consuming and require more expertise on BLM's staff. But these documents would give BLM the information for determining if the project should go forward before any land is disturbed.

Under Alternative 4 industry would use the best available technology and practices for actions on mining operations. These technologies might or might not directly apply to the mining industry.

Operations would also be required to post a bond for 100% reclamation and money for unplanned events. Calculating a bond for unplanned events would be difficult.

Reviewing Plans of Operations under Alternative 4 would increase BLM's workload. Under current funding and staffing levels projects would be delayed.

Inspection and Enforcement. Alternative 4 would require operators to have third-party contractors complete monitoring of the operation, and monitoring reports would have to be given to BLM for verification. The review of these documents would require more time and money for BLM.

If an issue of noncompliance arises, BLM would be required to take enforcement actions and automatically penalize the operator. BLM would issue penalties and could strain the working relationship between the agency and the operator. Mandatory penalties could make it difficult for BLM to attain compliance, would prohibit the approval of other permits, and would further strain working relationships. These types of automatic penalties could make it difficult for BLM and the operator to work out problems. On the other hand, penalties could keep some operations in compliance. Automatic noncompliance could increase BLM's workload. An estimated 1,000 notices of noncompliance for mining are expected to be issued on public lands during a 20-year period under Alternative 4.

Administration practices. Any appeal of BLM's decision would automatically stay the decision. The project would then have to be reviewed by the Interior Board of Land Appeals (IBLA) before the operation could continue. Historic data shows that this requirement could delay a project for up to 2 years. The use of appeals could create a backlog of cases and further delay IBLA's review and the operation. An appeal could be used to stop mining and could effectively shut down operations before they start.

Mineral Development. A mining decrease of 10% to 75% is projected to result from implementing Alternative 4. These changes are shown in Table 3-15.

Table 3-15. Changes in Mineral Activity under Alternative 4

Casual Use/ Suction Dredging	Small Exploration	Large Exploration	Small Placer	Large Placer	Small Open Pit	Large Open Pit	Small Underground	Large Underground	Industrial Minerals
-5 to -15%	-20 to -30%	-20 to -30%	-20 to -30%	-15 to -25%	-50 to -75%	-50 to -75%	-15 to -25%	-10 to -20%	-10 to -20%

Table 3-16 outlines the possible number of Plan-level operations over a 20-year period under Alternative 4.

Table 3-16. Number of Mineral Operations under Alternative 4 over a 20-Year Period

Type of Operation	Small Operations		Large Operations	
Exploration	5300	6050	610	700
Placer	1770	2010	560	640
Strip	190	220	45	50
Open Pit	270	540	260	530
Underground	90	100	120	130
Mill Site	340	380	90	100
Total	7,960	9,300	1,685	2,150

Under the assumptions in Appendix E, from 400 to 470 small Plans of Operations and from 80 to 110 large Plan of Operations could be submitted a year under Alternative 4. Over a 20-year period, from 7,960 to 9,300 small Plans of Operations and 1,685 to 2,150 larger Plans of Operations could be submitted. Table 3-17 shows acres that would be disturbed under these operations.

Table 3-17. Acres Disturbed under Alternative 4

Operation Size	**Acres Disturbed per Operation**	**Acres Disturbed per year**		**Acres Disturbed in 20 Years**	
Average Small	2	800	940	15,920	18,600

Average Large	50	4,000	5,500	84,250	107,500

Exploration. Under Alternative 4 all exploration would be conducted under Plans of Operations. These operations would lose the flexibility they had with Notices and require more time for Plan review. Exploration projects easily change during operations in response to the type of information one receives during drilling. These changes would not be easily managed as modifications to Plans of Operations. The need to visit BLM offices to review projects just for hand samples would also slow the process and cost people and organizations time and labor. People planning outdoor activities would have to plan far enough ahead to talk to the BLM office with jurisdiction before engaging in the activity. With BLM offices often so far away, people might have a difficult time discussing the project and getting it approved before engaging in outdoor recreation. BLM's authority to reject a project would further restrict areas open to mineral exploration and development.

Mining. Operators would experience delays in the permitting process because of all the new information and situations required for Plans. Bonding for 100% plus unplanned events would be difficult to establish for operations. Smaller operations disturbing less that 5 acres would have further delays in getting Plans approved because of the need to collect baseline information. Outdoor activities that before had required only a Notice or were considered casual use might require Plans of Operations. This requirement would restrict access to minerals for these types of operations such as the weekend use of suction dredges.

Alternative 5: NRC Recommendations

Administration of Surface Management Regulations. Alternative 5 would result in increased cost to the mining industry.

Casual Use. Under Alternative 5 casual use should only negligibly disturb the environment. But major problems would arise when groups get together to recreate, explore for minerals, or placer mine for gold. In these situations cumulative impacts could exceed negligible levels, resources would be damaged, and the disturbance would generally not be reclaimed.

Notices. Under Alternative 5 all exploration disturbing less than 5 acres could be operated under Notices. But any mineral activities on special status lands would still require Plans of Operations. Alternative 5 would also require bonding for Notice-level operations. Reviewing and accepting a bond would require more work for BLM but would provide a way to enforce reclamation and mitigation requirements.

Plans of Operations. Plans of Operations would be expanded to include all types and sizes of mining and milling, as well as exploration projects that disturb more than 5 acres or are in special status areas. BLM's workload would increase with mining operations being required to submit Plans of Operations.

BLM would need to review or coordinate several conditions before approving Plans. For Example, Plans of Operations may require a public comment period in coordination with the environmental analysis.

For operations under Plans Alternative 5 would require bonding for 100% of reclamation. Bonding would increase workloads by requiring BLM to review in more detail the reclamation plan. But bonding would allow for a complete interdisciplinary review of the reclamation plan and the complete reclamation of disturbed land if an operator defaults. As a result, mining companies would face more delays in starting or modifying their projects than they now do.

Inspection and Enforcement. Enforcement provisions of Alternative 5 would include the use of suspension orders and discretionary penalties, which BLM could assign for noncompliance. These orders and penalties would slightly increase the workload to develop the case and defend the orders and penalties. But BLM would have more legal recourse to be used against operators who refuse to comply.

Under Alternative 5, during a 20-year period, from 180 to 200 notices of noncompliance and suspension orders could be expected for Notice-level activity. From 230 to 260 could be expected for Plan-level activity.

Administration Practices. Mines proposed either for areas withdrawn from mineral entry or for extracting suspected common variety minerals, could be processed under either a Notice or a Plan of Operations. The operator might not have to demonstrate a valid claim before disturbing the surface. Potential environmental impacts could result, and the Federal Government could lose revenue, if BLM discretion is not used to verify claim requirements before accepting a Notice or approving a Plan.

Mineral Development. Implementing the NRC Recommendations Alternative is projected to decrease mining by 10% or less overall across the study area. These changes by operation type are shown in Table 3-18.

Table 3-18. Changes in Mineral Activity under Alternative 5

Casual Use/ Suction Dredging	Small Explor-ation	Large Explor-ation	Small Placer	Large Placer	Small Open Pit	Large Open Pit	Small Under-ground	Large Under-ground	Industrial Minerals
0%	0 to -5%	0 to -5%	-5% to -10%	0 to -5%	-5% to -10%	0 to -5%	-5% to -10%	0 to -5%	-5% to -10%

The largest potential decrease in mining could result when a Plan of Operations would be required for an operation that under the existing regulations would need only a Notice. These operations would mainly be small mining operations which were allowed under a Notice but now would be under a plan of operation. The cost model for small placer operations (see Appendix E) projects shows a potential 34% increase in some costs when a Plan of Operations rather than a Notice would have to be prepared.

Table 3-19 outlines the possible number of Notices and Plans that could be submitted over a 20-year period for different types of mining operations under the Proposed Action.

Table 3-19. Number of Mineral Operations under Alternative 5 over a 20-Year Period				
Type of Operation	Notice-Level		Plan-Level	
Exploration	7,180	7,560	830	870
Placer	0	0	2,980	3,140
Strip	0	0	270	290
Open Pit	0	0	1,970	2,080
Underground	0	0	240	270
Mill Site	0	0	540	580
Totals	7,180	7,560	6,830	7,230

Overall, mining is expected to decrease by 10% or less. The decrease would not necessarily to be reflected in the overall number of operations on public lands. The mining industry could absorb these changes through shorter mine lives, high cutoff grades, discontinued exploration, and lower profits.

For these assumptions, from 360 to 380 Notices and from 340 to 360 Plans of Operations would be filed each year under Alternative 5. Over a 20-year period, operators would file from 7,180 to 7,560 Notices and 6,830 to 7,230 Plans of Operations.

Table 3-20 shows the average acreage that Notice- and Plan-level operations would disturb under Alternative 5.

Table 3-20. Acres Disturbed under Alternative 5					
	Acres Disturbed				
	Per Operation	Per Year		In 20 Years	
Notice Level	2	718	758	14,360	15,120
Plan Level	2-50	7,400	8,870	149,980	158,460

<u>Exploration.</u> Under Alternative 5, operations disturbing less than 5 acres would continue to explore and develop mineral deposits by submitting a Notices. But Notices would require reclamation bonds at 100% of the cost of reclamation. This bonding requirement would increase operating costs for small independent geologists and prospectors, who could not easily obtain these bonds. The difficulty and uncertainty of obtaining bonding could affect exploration operations of all sizes.

<u>Mining.</u> All mining would require Plans of Operations under Altemative 5, and all formerly Notice-level mining operations would eventually require Plans of Operations if they expanded. All small operations (only 5 to 10 people) would have to develop Plans of Operations and environmental documentation. The environmental requirements and the level of detail for

any operation would be based on the site-specific locations and the type of operations proposed. Many small operators could be hard pressed to post the required bond at 100% of an operation's estimated reclamation cost. The range of change in mineral activity (-5% to -10%) would result from the uncertainty of obtaining the required data, the amount of data, and the detail of the data and the difficulty of obtaining a bond either through bonding companies or other methods.

HAZARDOUS MATERIALS AND WASTE MANAGEMENT

Affected Environment

Hazardous Materials Management

The term "hazardous materials" is defined in 49 CFR 172.101. Hazardous substances are defined in 40 CFR 302.4 and in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) Title III. Hazardous materials and substances may be transported, stored, and used at any mine. Typical processing chemicals include sodium cyanide, calcium oxide (lime), hydrochloric acid, antiscalants, flocculants, and sodium hydroxide. Cleaning solvents, blasting agents, and diesel fuel for mining equipment may also be used.

The Department of Transportation has compiled a list of materials classified as hazardous for transportation purposes (49 CFR 172.101) and prescribes packaging and labeling requirements for each designated hazardous material. This list includes the hazardous substances regulated under CERCLA as well as other types of chemicals. In addition to the hazardous substances described above, the transporting of sodium hydroxide, ammonium nitrate, class A explosives, diesel fuel, and calcium oxide (lime) must comply with Department of Transportation hazardous materials packaging and labeling requirements.

Chemicals used in mining must be stored in compliance with a variety of regulations and procedures. Fuel storage areas must be built with synthetic liners or a concrete containment area to store above-ground bulk fuel tanks. All other petroleum products and chemicals must be stored in lined containment areas with at least 110% secondary containment capacity. Lubricants are usually contained in a mobile service truck. Bulk lubricants and petroleum products must remain stored at the main mobile maintenance shop. Sodium cyanide is stored in areas physically separate from acid storage, and blasting agents and explosives must be stored and used on site according to Mine Safety and Health Administration regulations (30 CFR 56, subpart E). Users of blasting agents must maintain a valid Bureau of Alcohol, Tobacco, and Firearms permit.

Some mines are classified as large-quantity generators of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). A large-quantity generator generates more than 1,000 kilograms per month of RCRA-regulated hazardous waste (40 CFR 262). Other mines can be classified as conditionally exempt small-quantity generators of hazardous waste, as defined by RCRA. A small-quantity generator generates less than 100 kilograms a month of RCRA-regulated hazardous waste.

Laboratory waste that exhibits hazardous waste characteristics, including off-specification commercial chemicals and assay wastes, are managed as hazardous waste. A short-term hazardous waste storage facility is built for storing these wastes for up to 90 days. Hazardous wastes are hauled to an approved facility for disposal.

Hazardous wastes other than laboratory wastes are also managed in the short-term storage facility before being shipped to an off-site licensed disposal facility. These materials may include waste paints, thinner, and spill cleanup items. Spent solvents and used oils are returned to recycling facilities.

Waste Management

Mining also generates nonhazardous waste. Most of this waste includes mill tailings, waste rock, spent leach ore, and solvent extraction and eletrowinning wastes ("SX/EW"). Mine waste are excluded from regulation as hazardous waste under the Resource Conservation and Recovery Act of 1976 (RCRA): 40 CFR 261, mining waste exclusion: final rule, *Federal Register* Vol. 54, No. 169, September 25, 1989: 40 CFR parts 260, 261, 262, Mining Waste Exclusion and Definition of Designated Facility; proposed rule, *Federal Register* Vol. 54, No. 184, September 25, 1989; 40 CFR 260, 261, 262, Mining Waste Exclusion; Section 3010 Notification for Mineral Processing Facilities; Designated Facility Definition; Standards Applicable to Generators of Hazardous Waste; final rule, *Federal Register* Vol. 55, No. 15, January 23, 1990. These wastes are managed on the mine site through the site-specific reclamation or closure plan. Their disposal method depends on their chemical nature and potential to generate leachate.

Nonhazardous wastes generated by mining include waste paper, wood, scrap metal, used tires, and other domestic trash. These materials are disposed of in designated landfills. These sites are usually developed onsite as part of the operating and reclamation plans and are covered under 40 CFR 268. Analytical procedures at an on-site laboratory generate hazardous and nonhazardous waste. Nonhazardous solid wastes from the laboratory are disposed of at the landfill.

To date, the U.S. Environmental Protection Agency (EPA) has not established a regulatory framework for regulating mining wastes under Subtitle D of the Resource Conservation and Recovery Act (RCRA). For purposes of this EIS, BLM assumes that this status will continue. If EPA does establish regulations for mining wastes, BLM would coordinate with EPA.

Emergency Response

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) creates a framework for the federal response to hazardous substance releases. For this program to be effective, the Federal Government must be informed immediately of releases that may require rapid response to protect public health and the environment. Notification is needed if an amount of a hazardous substance equal to or greater than its reportable amount is released to the environment within a 24-hour period. Following notification, federal workers evaluate the need for a federal response, and removal or remedial actions are initiated, if necessary. For emergency response planning under the Superfund Amendments and Reauthorization Act (SARA), Title III, a threshold planning quantity is established for each hazardous substance. The threshold planning quantity and reportable quantity values for sodium cyanide are 100 lbs. and 10 lbs. respectively. CERCLA excludes petroleum products as hazardous substances. If an operation is expected to store chemicals that exceed their threshold planning levels, an emergency response plan is required.

Mining operations that store, use, or generate regulated materials must have an emergency response plan as required by CERCLA (Table 3-21). Part of the emergency response plan is a

Table 3-21. Outline for Emergency Response Plan

I. Introduction

II. Emergency Coordinator Information; Emergency Phone Numbers (40 CFR 262.34 [d][5])

III. Preparedness, Prevention Contingency Plan
- 1) PPC Plan (40 CFR 265, subpart C and ARS 26-347)
  - A. Maintenance and Operation of Facility
  - B. Required Equipment
  - C. Testing and Maintenance of Equipment
  - D. Access to Communication or Alarm Systems
  - E. Required Aisle Span
  - F. Arrangements with Local Authorities
  - G. Transportation Routes
- 2) Hazardous Waste Training for Employees
- 3) Emergency Plan for Hazardous Materials
- 4) Disaster Plan
- 5) Acid Handling Procedures
- 6) Emergency/safety Equipment Lists and Locations; Evacuation Plan and Routes
- 7) Spill Prevention Control Countermeasure Plan
- 8) Maps, Illustrations

spill prevention, control, and countermeasure (SPCC) plan. This plan would cover all materials stored at the mine site and must be reviewed and updated at least every 3 years, or whenever major changes are made in managing these materials.

The emergency response plan outlines actions that would be initiated, and by whom, in event of a release or spill from a component of a fluid management system. The fluid management system includes the process recovery system, piping, pumping, ditches, and other items used in the managing and fluid containment of the leaching and processing facilities. The emergency response plan also applies to spills of stored chemicals and petroleum products. All chemicals must be stored and handled according to manufacturer recommendations and state regulations.

The material safety data sheets for all chemicals used on a mine site and emergency response plan and the emergency response plan itself should be kept where they are readily accessible by workers.

Release and Spill Reporting

Discoverers of chemical or petroleum product spills or accidental discharges from any component of the fluid management system must immediately shut down that portion of the failed system to eliminate the discharge and then notify their immediate supervisors. Procedures should then be followed, in response to the time of the event, including other proper notification of mine workers, as specified in the emergency response plan.

The notification process usually entails contacting local, state, and federal people who have responsibilities in emergency response. Depending on the nature of the release or spill, equal to or greater than that of its reportable quantity, the National Response Center could be contacted. These notifications are based on local, state, and federal requirements and outlined in the emergency response plan.

Environmental Consequences

Impacts Common to All Alternatives

The storage of chemicals, hazardous waste, and other waste is regulated by the acts and regulations outlined previously. None of the alternatives would reduce the effectiveness of emergency responses to releases and spills. The risks of transportation accidents, equipment failure, and human error resulting in a spill or release would continue. The level of risk would be determined by the relative amount of activity and proximity to environmentally sensitive lands and habitats. All spills or releases during any operation will have some form of risk analysis completed to determine the level of cleanup needed to meet all state and federal regulations and determine the natural resource contamination risk acceptable to the land management agency.

These regulations and the expanded regulatory environment have had a cumulative affect on the mining industry's cost of doing business. The new state and federal regulations are requiring more time and monitoring from the operator to meet these new requirements. These types of activities impose costs to operations. These costs range from less than 1% of the total cost of the operations to as high as 20% of the overall operational budget._These cost vary greatly, depending on a mineral operation's site-specific resource concerns.

Land use restrictions from zoning and mineral withdrawals will continue to restrict access to areas for mineral development. The changing policies of agencies in response to environmental degradation, political pressures, and court cases will change how industry will operate on public lands.

New hazardous materials issues are affecting the mining industry. On May 1, 1997, EPA published a final rule to expand the Toxic Release Inventory Reporting Program under Section 313 of the Community Right-To-Know Act (EPCRA) by adding metal mining, among other industrial groups. Reporting requirements are extensive, and initial reports were due by July 1, 1999. On another waste management issue, in May 1998, EPA published land disposal restrictions for mineral processing wastes. These restrictions include treatment standards based on the performance of best demonstrated available technologies (BDAT). [See 63 Fed. Reg. 28556 (May 26, 1998).] The minerals industry will continue to experience increased regulations and restrictions from state and federal agencies.

Alternative 1: No Action

The improper management of mine waste could affect natural resources. Under current law–the

Bevill Amendment– most mine wastes are exempt from the hazardous classification and regulation by legal definition. While some mine wastes might not pass a nonhazardous testing standard, they would still legally be handled as nonhazardous waste. Pond sludge is an example of mine waste that might be technically hazardous yet legally could be reclaimed in place. Depending on how materials are reclaimed, they might leach into soils and ground water. Soils could attenuate heavy metals so that they could be absorbed by plants and enter the food chain.

Although there are no specific standards other than isolation and control of toxic or deleterious substances, the Plan of Operations review process provides a mechanism for BLM to consider mine waste character and provide for waste disposal in an environmentally sound manner on a site specific basis. But mine waste is difficult to manage because some operators are reluctant to test waste that is exempt from classification as a hazardous material. When processing a mining Notice it becomes even more difficult to ensure that mine waste is properly handled because of the limited review times and content requirements.

Alternative 2: State Management

Under some state programs, mine waste might not be characterized adequately to determine its potential for causing contamination. Without knowledge of the material's pollution potential, an operation might not be properly reclaimed. BLM, as land owner, might not know of the waste disposal situation and could be held environmentally and financially liable for the cleanup if onsite disposal later degrades the environment.

Alternative 3: Proposed Action

Under the Proposed Action several factors would reduce the potential for both hazardous and nonhazardous mining-related wastes to harm the environment. Eliminating the Notice provision for small mines would give BLM more opportunity to review, characterize, and plan for proper disposal of mine wastes from these small operations. The addition of reclamation bonding would ensure that wastes are properly disposed of if the operator is unable to do so. The information requirements specified for characterization, reclamation, and monitoring as part of a Plan of Operations would give BLM the information needed to evaluate the potential impacts of mine waste management. Mine waste testing would determine the potential for generating unacceptable leachate. The testing would also ascertain the best approach to reclaiming mine waste disposal areas. The expanded detail in the performance standards would reduce confusion over reclamation requirements when it comes to waste disposal and provide for greater consistency across BLM offices.

Alternative 4: Maximum Protection

Under Alternative 4 potentially toxic mine wastes such as pond sludges and lab wastes could not be disposed of on BLM-administered lands. This prohibition would, eliminate any potential impacts or added cost to BLM from improper disposal of this material. Other mining waste products such as tailings and waste rock could still be disposed of on BLM lands. The Plan of Operations review process would be used to determine the mine waste character, placement, reclamation, and monitoring needs. This process would reduce potential environmental impacts similar to those under Alternative 3. In addition, expanded bond coverage for unplanned events such as spills or facility failures could offset the government's cost in responding to and starting removal or remedial actions for hazardous waste or mine waste environmental releases.

Alternative 5: NRC Recommendations

The elimination of mining under a Notice and the bonding of all mining and milling operations would give BLM more opportunity to review, characterize, and plan for proper disposal of mine wastes from these small operations. The addition of reclamation bonding would ensure that waste is properly disposed of if the operator cannot do so. Alternative 5 would increase the level of environmental protection from improper mine waste management beyond that provided by the existing regulations. But Alternative 5 would not be as beneficial as Alternative 3, with its expanded Plan content requirements and specific performance standards.

CLIMATE

Affected Environment

The study area consists of several major climatic types. Temperatures vary mostly with latitude, elevation, moisture, and to a lesser extent local microclimate. At higher elevations in the study area freezing temperatures are possible throughout the year.

Annual precipitation is highly variable, due mainly to the orographic effect of local topography and the large-scale variability of storm tracks in respect to large water bodies. Except in coastal areas, the Pacific Southwest, and areas with high snowpack, most precipitation comes from thunderstorms in the spring to fall. Snowfall is possible at higher latitudes and elevations throughout the year, with snow accumulation amounts increasing with elevation.

Upper-level winds generally prevail from the west and southwest (with alternating southerly flow in the east), but ground-level winds often reflect local terrain. For example, the diverse and rugged terrain in mountains results in complex wind flows and surface winds. Synoptic (pressure gradient) winds may be channeled or forced around hills, but without strong gradient flows, diurnal upslope/downslope winds predominate. Upslope winds usually blow on sunny mornings when the air at higher elevations heats rapidly and rises. Downslope winds blow when the air near the ground cools, becomes dense, and sinks downward along drainages.

The extent of vertical and horizontal mixing is related to the atmospheric stability and mixing depth. Unstable conditions normally result from strong surface heating (typical of summer afternoons), producing vertical winds. Neutral conditions reflect a breezy, well-mixed atmosphere. Stable conditions (enhanced by rapid radiative cooling and downslope drainage, high pressure systems, etc.) produce the least amount of dispersion.

Although the atmospheric mixing varies throughout the study area, dispersion is normally good in spring and summer, but limited in winter. Inversions are formed under stable conditions, trapping air pollutants within a layer of the atmosphere. Moderate summer inversions are typical during the evening and dissipate at dawn. Winter inversions are stronger and last longer. Inversions are enhanced by weak pressure gradients, cold clear nights, snow cover, and lower elevations.

Public lands in the study area are found in several general climatic regions, including Arctic Alaska, Interior Alaska, Coastal Alaska, Coastal Pacific (North and South), California Central Valley, Columbia Plateau/Snake River Basin, Great Basin, Southwestern Desert, Wyoming Basin, Colorado Plateau, Western Great Plains, Eastern Temperate Plains, and Southern Subtropical Plains. In addition, microclimatic conditions make mountainous, highland climates highly variable, including the Cascade/Sierra Nevada Mountains, Northern Rocky Mountains, and Southern Rocky Mountains climatic regions. Even these regional climatic divisions are necessarily broad generalizations of highly complex conditions.

Environmental Consequences

Although locatable mineral development would not significantly affect climate, it is appropriate to examine the impact of climate on postmining vegetation reclamation (McKee and others 1981). Throughout most of the United States the timing and amount of precipitation are the main limiting factors for vegetation growth. Although temperatures also affect growth, warming temperatures typically dictate when growth begins, not if it will occur. Major exceptions to this assumption include the following:

- Coastal Alaska, the northern coastal Pacific, the eastern temperate plains, and the southern subtropical plains, where precipitation is abundant.
- Arctic and interior Alaska and portions of the Cascades/Sierra Nevada, and northern and southern Rocky Mountains, where extreme cold conditions inhibit plant growth.
- Portions of the Great Basin and the southwestern deserts, where extreme summer temperatures often create both spring and fall growing periods.

By comparing the short-term weather situation to long-term climatic conditions, vegetation managers can adjust the timing and methods for postmining vegetation reclamation. For example, dry soil conditions resulting from multiple years of below-normal precipitation will require excess moisture to adequately prepare vegetation for the growing period. Similarly, extended periods of summer moisture may compensate for a dry spring. Other biological relationships will determine the proper selection of seed and root stock, the occurrence and timing of plant development, and root growth.

AIR QUALITY

Affected Environment

The air quality throughout much of the United States is unknown. Only limited monitoring data exists for most pollutants outside urban areas. But in the undeveloped regions of the West ambient pollutant levels are expected to be near or below measurable limits. Locations vulnerable to decreasing air quality from extensive development include immediate operation areas (mills, power plants, prescribed fires) and local population centers (automobile exhaust, residential wood smoke).

Carbon monoxide (CO) is formed by incomplete combustion of hydrocarbon-based fuels. Elevated CO levels are common in urban areas with significant transportation, residential, and industrial emission sources.

Historically, lead was added to gasoline, and elevated lead levels were found in areas with large numbers of automobiles. Today, elevated lead levels are found only in areas immediately next to operating (and historic) lead mines and smelters.

Nitrogen dioxide is formed when hot combustion gases are released quickly into the ambient atmosphere. Automobiles, fossil-fueled electrical generating facilities, and other industrial combustion are the major sources of nitrogen dioxide emissions.

Ozone is a secondary pollutant, formed under specific atmospheric conditions due to ambient levels of other primary emissions (such as volatile organic compounds and oxides of nitrogen). High ozone concentrations are typically found where these primary pollutants combine in strong sunlight and under relatively stable mixing conditions.

Sulfur dioxide is formed when hydrocarbons (or other materials) containing trace levels of sulfur are burned, including coal-fired electrical generating facilities, mineral products enhancement (such as smelting or roasting of ores), and other industrial combustion sources (particularly using diesel fuels).

Particulate matter concentrations are expected to be higher near industrial areas, towns, and unpaved roads. Inhalable particulate matter (PM-10) levels are high in areas with significant combustion sources (urban areas, industrial facilities, residential wood smoke).

Air quality regulations consist of the National Ambient Air Quality Standards (NAAQS) and the Prevention of Significant Deterioration (PSD) increments (Table 3-22). The NAAQS limit the amount of specific pollutants allowed in the atmosphere: carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and inhalable particulate matter. The U.S. Environmental Protection Agency (EPA) recently established fine particulate matter (PM-2.5) standards, although it will take some time before background measurements and regional levels can be determined. Individual state standards include these parameters but may also be more stringent or include other air pollutants. Air pollutant concentrations are usually measured as micrograms per cubic meter.

Table 3-22. National Ambient Air Quality Standards and Prevention of Significant Deterioration Increments (g/m^3)

	National Ambient Air Quality Standards			Prevention of Significant Deterioration Increments		
Pollutant	Averaging Time (a/)	Primary Standard (b/)	Secondary Standard (c/)	Class I	Class II	Class III
Carbon monoxide	8-hour	10,000	10,000	----	----	----
	1-hour	40,000	40,000	----	----	----
Lead	Quarterly	1.5	1.5	----	----	----
Nitrogen dioxide	Annual	100	100	2.5	25	50
Ozone	8-hour	157	157	----	----	----
	1-hour (d/)	235	235	----	----	----
Sulfur dioxide	Annual	80	----	2	20	40
	24-hour	365	----	5	91	182
	3-hour	----	1,300	25	512	700
Particulate matter (PM-10)	Annual	50	50	4	17	34
	24-hour	150	150	8	30	60
Particulate matter (PM-2.5)	Annual	15	15	----	----	----
	24-hour	65	65	----	----	----

Sources: 40 CFR 50.4 through 50.12; 40 CFR 51.166© and 52.21(c); 62 FR 38652 and 62 FR 38856 (July 18, 1997)

(a/) Annual standards are not to be exceeded; short-term standards may be exceeded once per year.

(b/) Primary standards are designed to protect public health.

(c/) Secondary standards are designed to protect public welfare.

(d/) The 1-hour ozone standards are to be implemented on an interim basis until the 8-hour standards go into full effect.

Areas that consistently violate the NAAQS because of human-caused activities are classified as "nonattainment" areas and must implement a plan to reduce ambient concentrations below the maximum pollution standards. Under EPA's "Fugitive Dust Policy," areas that violate particulate matter standards but lack significant industrial or population particulate sources to cause such violations are designated "unclassified" (neither attainment nor nonattainment). Most rural areas of the country have been designated as either attainment or unclassified for all pollutants.

As required by the Federal Land Policy Management Act and the Clean Air Act, BLM cannot conduct or approve any activity that does not comply with all local, state, tribal, or federal air quality laws, rules, standards, and implementation plans. Therefore, before any activity potentially affecting air quality can be approved and conducted, project-specific air quality assessments must be conducted to confirm that all requirements will be met. In addition, for activities proposed within nonattainment or maintenance areas (previous nonattainment areas that are now achieving or maintaining the NAAQS), BLM must conduct a separate "conformity" analysis and disclose potential air quality impacts and show that those impacts would meet all requirements.

The Prevention of Significant Deterioration (PSD) program applies in "attainment" and "unclassified" areas, whereby areas are classified by the additional amounts of nitrogen oxide, sulfur dioxide, and PM-10 (inhalable particulate matter) degradation that would be allowed above a legally defined "baseline" level. PSD Class I areas–predominately national parks and large wilderness areas–have the greatest limitations; virtually any more degradation would be significant. Areas where moderate, controlled growth can take place were designated as PSD Class II. PSD Class III areas allow the greatest degree of impacts, although no PSD Class III areas have been designated to date.

Congress designated 158 mandatory Class I areas on August 7, 1977 (Figure 3-1; NPS 2000). Several Indian tribes have also redesignated their lands to PSD Class I. Most mandatory PSD Class I areas are in the mountainous regions (although some are also at lower elevations), and are managed by either the Forest Service, National Park Service, or U.S. Fish and Wildlife Service. A few mandatory PSD Class I areas are jointly administered by BLM and the Forest Service. Otherwise, most BLM-administered lands are classified PSD Class II.

[Insert Figure 3-1. Prevention of Significant Deterioration (PSD) Class I Areas. (Source: NPS 2000)]

Environmental Consequences

Impacts Common to All Alternatives

No provisions in the regulations would directly affect the amount and type of impacts to air quality under the four alternatives. Impacts to air quality would result from secondary effects of the regulations on the amount and type of mining activity.

The most significant impacts to air quality under all alternatives would result from direct development (extraction, transport, processing), mineral products enhancement (refining, smelting, roasting, combining), and postmining reclamation. Direct impacts could include increases in noise, dust, and exhaust generated by surface preparation, blasting, extracting, crushing, hauling, secondary processing, and transportation/loadout activities. Depending on the type of material extracted, further enhancement processes can generate large levels of gaseous and particulate matter pollutant emissions, often with relatively tall emission stacks, which can degrade air quality (pollutant concentrations and secondary impacts to visibility and atmospheric deposition) over large areas. Finally, as mining diminishes, continuing particulate matter impacts can be significant due to windblown (or fugitive) dust, until adequate postmining reclamation and vegetation are established and maintained.

Impacts from direct development and product enhancement could be significant (depending on project-specific conditions) but would exist only during the period of development (life of project). Disturbed-land impacts would typically be smaller in scale but could continue until successful postmining vegetation is established.

Because BLM can approve only activities that comply with all local, state, tribal, and federal air quality laws, rules, standards, and implementation plans, this analysis assumes that impacts to air quality would meet these standards. Although the precise air quality impact from mining cannot be quantified now, these procedures would assure that BLM-authorized practices conform to all air quality requirements.

Alternative 1: No Action

Impacts to air quality would continue at about current levels and would be generally proportional to the amount of activity and acreage disturbed. All operations would continue to meet air quality standards as required under the Clean Air Act, state regulations, and the existing 3809 regulations.

An evolving practice used to facilitate metal recovery from sulfide ores is to roast the ore to oxidize and remove the sulfur. This practice emits sulfur dioxide. As part of a general trend, precious metals are being extracted from deeper portions of ore deposits, which contain higher amounts of sulfide minerals. This trend is expected to continue, and sulfur dioxide would be an increasing component in emissions of many mining operations. Although emission levels would continue to be limited under permit systems, sulfur dioxide emissions from the mining sector would increase.

Alternative 2: State Management

Impacts under State Management would be similar to those under No Action. All operations would continue to meet air quality standards as required under the Clean Air Act and state regulations. The projected increase in mineral activity by about 5% would result in a proportional increase in the emission of air pollutants. Although projects would continue to be required to meet standards, there would be a proportional cumulative increase in overall emissions.

Alternative 3: Proposed Action

Impacts under the Proposed Action would be similar to those under No Action. All operations would continue to meet air quality standards as required under the Clean Air Act and state regulations. The projected 5% to 50% decrease in mineral activity would result in a proportional decrease in the emission of air pollutants. In addition, the reclamation measures required by the proposed regulations would improve the reclamation success rate and shorten the amount of time that disturbed areas would be left unreclaimed, thus decreasing the potential for fugitive dust emissions. Projects would continue to be required to meet standards, and there would be a proportional cumulative decrease in overall emissions.

Alternative 4: Maximum Protection

The projected decrease of up to 75% in overall mineral activity and acreage disturbed under Maximum Protection would result in a proportional decrease in the emission of air pollutants. But offsetting this decrease would be the requirement for complete backfilling of all open pit mines. This backfilling would create more fugitive dust and equipment exhaust emissions. On the other hand, restricting the mining of high-sulfide ores would decrease the potential for sulfur dioxide emissions. In summary, projects would continue to be required to meet standards, and there would be a proportional cumulative decrease in overall emissions.

Alternative 5: NRC Recommendations

Impacts under the NRC Recommendations Alternative would be similar to those under No Action. All operations would continue to meet air quality standards as required under the Clean Air Act and state regulations. The projected decrease in mineral activity by about 5% would result in a proportional decrease in the emission of air pollutants. Projects would continue to be required to meet standards, and there would be a proportional cumulative decrease in overall emissions.

WATER RESOURCES

Affected Environment

Regional Hydrogeology

The United States can be divided into several ground water regions, each having similar characteristics for the occurrence and movement of ground water (Heath 1984).

Great Basin and Southern Alluvial Valleys. This province includes most of Nevada and parts of eastern and southern California, western Utah, southern Arizona, southwest New Mexico, and small areas in southeast Oregon and Idaho. This region closely approximates the boundaries of the Basin and Range Physiographic Province described by Fenneman (1931), except in New Mexico. The characteristic physiographic features of the Basin and Range Province are the north-south trending mountain ranges and intervening basins filled with alluvial deposits, which can be thousands of feet deep.

This region's ground water occurs in aquifers that are not continuous, or regional, because of the region's complex faulting and the many impermeable mountain ranges that often impede ground water flow between basins. But some basins are part of multi-basin flow systems connected by perennial streams or by subsurface flow through the basin fill or permeable bedrock that separates the basins. Ground water flow through these systems can be continuous for hundreds of miles.

Three main aquifer types collectively referred to as the Basin and Range aquifers (Planert and Williams 1995) are volcanic-rock aquifers, which consist mainly of the following:

- Tuff, rhyolite, or basalt of Tertiary age.
- Carbonate-rock aquifers, which are mainly limestones and dolomites of Mesozoic and Paleozoic age.
- Basin-fill aquifers, which are mainly unconsolidated to semiconsolidated sand and gravel of Quaternary and late-Tertiary age.

Older basin-fill deposits are generally deeper, are more consolidated, and can be less permeable (conglomerate, sandstone, siltstone, mudstone, freshwater limestone, evaporite beds, tuff, and interbedded lava flows). Any or all of these three aquifer types may be in or underlie a basin and constitute three separate sources of water. The aquifers, however, may be hydraulically connected to form a single source. Other rock types within the region (such as schists, granites, shales) have low permeability and block the flow of ground water.

Except for small areas that drain to the Colorado River, no streams that originate within the Basin and Range Province carry water to the oceans. Practically all the precipitation that falls in the area is returned to the atmosphere by evapotranspiration, either directly from the soil/alluvium or from the many lakes and playas in the lowest points of the basins.

[Insert Figure 3-2. Ground Water Regions Delineated by Heath (1984).]

The centers of many basins consist of flat-floored, vegetation-free areas known as playas onto which ground water may discharge and on which overland runoff may collect during intense storms. The water that collects in these playas evaporates relatively fast, leaving a thin crust deposit of soluble salts that were dissolved in the water (Heath 1984). These water bodies represent discharge points for the alluvial aquifers (Planert and Williams 1995).

This region is the driest area in the United States. Large parts of it are classified as semiarid and arid. Annual precipitation in the valleys in Nevada and Arizona ranges from 4 inches in the low-lying valleys to 16 inches in some of the high valleys. In the mountainous areas throughout the region precipitation ranges from 16 to 35 inches on the highest peaks (USGS 1985).

Water quality of unconsolidated aquifers in the Basin and Range Province varies from basin to basin. Water is generally fresh at basin margins and on the slopes of alluvial fans. Dissolved solids concentrations in these areas are generally less than 500 mg/liter. Locally, saline water is present near some thermal springs and where basin fill aquifers contain large amounts of soluble salts, such as aquifers in the upper and middle parts of the Humboldt River Basin. In discharge or sink areas, such as the Carson and Salton sinks and in parts of Death Valley, the dissolved solids concentrations can exceed that of sea water (35,000 mg/liter).

Ground water beneath playas in small closed basins may be brackish, but typically the dissolved solids concentrations are not as high as those in major terminal sinks. Although highly mineralized water is common beneath playas, a deeper fresh water system might be present in some areas (Planert and Williams 1995). Water in bedrock units is generally of good quality, with some variations depending on the rock type and the flow path.

Western Mountain Ranges. This region includes a large extent of mountain ranges in an arc from the Sierra Nevada in California, north through the Coast Ranges and Cascade Mountains in Oregon and Washington, east and south through the northern Rocky Mountains in northern Idaho and western Montana, and south into the Bighorn Mountains in Wyoming and the Wasatch and Uinta mountains in Utah (Figure 3-2). Collectively this area is referred to as the Western Mountain Ranges ground water region as described by Heath (1984).

These mountain ranges surround the Columbia Plateau regional aquifer, a large area of basalt flows. Most of the area is drained by the Columbia River, its tributaries, and other streams that discharge to the Pacific Ocean. Exceptions are streams that flow to closed basins in southeast Oregon and northern Nevada and to Great Salt Lake in northern Utah (Whitehead 1994).

The region also includes the southern Rocky Mountains, which extend from Laramie, Wyoming, south through central Colorado into the Sangre de Cristo Range in northern New Mexico. The mountain ranges generally consist of granitic and metamorphic rocks flanked by consolidated sedimentary rocks (mainly sandstones, shales, and limestone). Narrow intermontane valleys are filled with relatively thin, coarse, bouldery alluvium eroded from the higher slopes.

The larger valleys (intermontane structural basins and down faulted troughs) are filled with moderately thick deposits of coarse-grained alluvium deposited by streams washing down from the mountains (Heath 1984). These deposits often form thick alluvial fans along mountain fronts and are recharge areas for water moving into the basin sediments.

Intermontane valleys contain unconsolidated alluvial deposits consisting mainly of sand and gravel layers that can supply large amounts of water to wells. Many large-yield public supply wells and thousands of domestic wells have been drilled in these units. These aquifers are generally not on public land.

The mountains in this region are not considered principal aquifers. Ground water is of limited availability, adequate for domestic use and livestock watering. Ground water in some of the intermontane valleys is more abundant and provides water to wells for large-yield irrigation supplies. Some unconsolidated aquifers occur along stream channels and provide limited amounts of ground water. Depths to ground water can range from a few feet near streams and in the mountains to several hundred feet in the sedimentary deposits that fill the intermontane basins.

Precipitation is high in the mountain ranges of both Oregon and Washington. Up to 160 inches of rain falls annually on the western slopes of the Coast Range. Up to 140 inches of rain falls in the highest peaks of the Cascade Range. In eastern Oregon and Washington, rainfall is much less, and some areas receive less than 10 inches.

The mountains in western Montana receive a little more than 100 inches per year precipitation at the highest elevations. Much of the lower mountainous areas receive 12-40 inches annually. Streamflow is highest from May through June because snowmelt increases flow during the spring and early summer (USGS 1985).

In Wyoming, precipitation is highest in the northwest, averaging about 40 inches per year in the highest mountains. Elsewhere in Montana’s lower mountains and plains, precipitation amounts to about 7 inches per year. Major streams in the mountains are the Snake, Bighorn, and Wind rivers (USGS 1985).

Surface water is sustained largely by snowmelt in the mountainous western two-thirds of Colorado. Runoff in the western mountains is highest during spring and early summer, the result of melting snowpack in the Rockies. Mountain precipitation ranges from 12 to more than 30 inches per year. Intermontane valleys receive 8 to 12 inches per year. The Colorado River and its tributaries drain most of the mountain areas. The Arkansas River and Rio Grande and their tributaries drain the region’s south.

Colorado Plateaus and Wyoming Basin Aquifers. The Colorado Plateaus aquifers underlie most of western Colorado, northern New Mexico, northeast Arizona, and eastern Utah. The Wyoming Basin includes south-central Wyoming (Figure 3-2). In general, the aquifers in this region consist of moderately to well-consolidated sedimentary rocks that are permeable and in places can store and transmit large amounts of ground water. Most of the aquifers consist of sandstone. But limestone, volcanic rocks, and unconsolidated alluvium also contain water in a few places (Driscoll 1986). The region's main sources of ground water (sandstones) contain water in both primary and secondary porosity in interconnected pore spaces and in fractures. The main aquifers of this region are the following:

- Uinta-Animas aquifer
- Mesaverde aquifer
- Dakota-Glen Canyon aquifer
- Coconino-DeChelly aquifer.

Some locally productive and important aquifers throughout the region are not part of these units (Robson and Banta 1995).

Relatively impermeable confining units separate each of the main aquifers in the Colorado Plateaus. The two thickest confining units are the Mancos shale, which underlies the Mesaverde aquifer, and the Chinle-Moenkopi formations, which underlie the Dakota-Glen Canyon aquifer system (Robson and Banta 1995).

Unconsolidated deposits are of relatively minor importance as aquifers in the region. Thin deposits of alluvium that can yield small to moderate amounts of ground water occur along parts of the valleys of major streams, especially next to the mountain ranges in the region's north and east (Heath 1984).

Water levels are generally a few hundred to several hundred feet below ground surface, except in the alluvial deposits near streams. There ground water is generally a few feet to a few tens of feet below ground surface.

Surface water is characterized by sharply incised valleys with many ephemeral streams that drain the lower mountain ranges. Average annual precipitation ranges from about 8 inches in the lower valleys to 40 inches in the highest mountain crests. Major drainages are the Colorado, Yampa, and White rivers in Colorado and the Green River in Wyoming.

Columbia Plateau. The Columbia Plateau, in the ground water region referred to as the Columbia Lava Plateau (Heath 1984), includes eastern Washington and Oregon, southern Idaho, and small areas in northeast California and northern Nevada (Figure 3-2). The region has sequences of lava flows, ranging in thickness from 100 feet next to the bordering mountain ranges to more than 3,200 feet in south-central Washington and southern Idaho (Heath 1984). The lava flows form the region's main aquifer.

Unconsolidated-deposit aquifers are important sources of high-yield wells in some areas and can produce several thousand gallons per minute. More commonly, yields are less than a 100 to a few hundred gallons per minute.

Surface water abounds in the region, with many rivers developed for irrigation and recreation. The area is drained by the Columbia and Snake rivers, their tributaries, and other streams that discharge to the Pacific Ocean (Whitehead 1994). Some drainage is into southern Idaho, and perhaps northern Nevada.

Much of the Columbia Plateau region is in the "rain shadow" east of the Cascade Range. As a result, precipitation is limited over much of the area. Precipitation in the region ranges from 7 to 47 inches per year, but much of the area receives less than 20 inches per year. Many of the smaller streams are dry by summer's end.

Alaska. Aquifers have been mapped in detail only in parts of the widely separated population centers–Fairbanks, Juneau, Anchorage, and Kenai-Soldotna . All water-yielding formations are grouped into two main aquifers–unconsolidated alluvium and glacial outwash deposits, and bedrock. Nearly all ground water development has been in the unconsolidated aquifers. Only about 1% of the water has been derived from bedrock aquifers.

A data base adequate to describe areal variations in the chemical quality of ground water exists only for a few places, mainly near population centers. Most of the unconsolidated aquifers contain ground water of good quality, having less than 400 mg/l of dissolved solids. But saline ground water is present in many of the subpermafrost aquifers in river basins in the central part of the state, for example, in the Copper River Basin. Water quality is affected by the marine sedimentary rocks that underlie much of the basin. Saline waters are also found in the coastal areas, having dissolved solids concentrations of up to 6,400 mg/l (USGS 1988).

From the standpoint of ground water availability and well yields, Alaska is divided into three zones. In the zone of continuous permafrost, ground water occurs beneath the permafrost and also in small, isolated, thawed zones that penetrate the permafrost beneath large lakes and deep holes in the channels of streams. In the zone of discontinuous permafrost, ground water occurs below the permafrost and in sand and gravel deposits that underlie the channels and floodplains of major streams. Water in this zone, contained in silt, clay, glacial till, and other fine-grained deposits, is usually frozen. In the zone not affected by permafrost, which includes the Aleutian Islands, the western part of the Alaska Peninsula, and the southern and southeast coastal areas, ground water occurs both in the bedrock and in the relatively continuous layer of unconsolidated deposits that mantle the bedrock (Heath 1984).

Recharge of aquifers occurs only when the ground is thawed in the areas not underlain by permafrost. This period lasts only from June through September. Because the ground is frozen even in nonpermafrost areas, relatively little recharge occurs in interstream areas by infiltration of water across the unsaturated zone. Instead, most recharge occurs through the channels of streams as they cross alluvial fans or flow in alluvial fill valleys. Infiltration rates can be high in some of the coarser alluvial sediments (Heath 1984).

Impact of Mineral Activity on Water Resources

Exploration for mineral deposits involves drilling; developing shafts, inclines, or adits into the ore deposit; and digging test pits or trenches. Drill holes from exploration can affect water resources. If the drill hole is not plugged or is improperly plugged, water from different aquifers can mix. This mixing can degrade the water quality of all or several aquifers.

Hydrologic investigations are sometimes part of an advanced exploration phase, requiring the drilling of water wells for aquifer tests to evaluate the expected aquifer zones or to evaluate aquifer characteristics. Monitoring wells may be installed to monitor ground water levels before mining. Determining water quality before mining is often part of the final phase of exploration and ore delineation.

These activities normally would not seriously affect water resources except in rare cases. Large amounts of water are sometimes pumped during the late exploration phase to test aquifers or to remove water from development workings. Discharge of the pumped water can be of concern if the water quality is poor. Pumped water is sometimes reinjected or infiltrated back into the ground using ponds. The disposal water can contain elevated levels of soluble salts, trace metals, and chlorides.

Mining can degrade ground and surface water quality and quantity in several ways. Each mine has features such as extraction areas and mill facilities that can affect water resources.

Mineral extraction areas or pits for removing mineral material for processing. These extraction areas affect water resources through dewatering, creation of pit lakes, aquifer disturbance, and physical removal or rerouting of water courses. Ground water quantity is affected by the removal of ground and surface water through dewatering.

Waste material storage in either tailings impoundments or waste rock dumps where high-volume waste material is placed. Waste materials affect water resources though acid rock drainage, spills or leaking of ponds, and other leaching of heavy metals.

Chemical or physical processing plants that extract or concentrate the desirable mineral for refinement or use. These plants include heap leach facilities, placer gold separators, and flotation plants. Water resources are affected through chemical spills and leachates from processed material.

Ancillary facilities such as access roads, powerlines, lab buildings, maintenance sheds, and other facilities and features needed for mining. Water resources are affected mostly through erosion and increasing sediment loading during runoff events.

Dewatering. Required when mining below the water table, dewatering is the process by which several wells are installed around the pit area and pumped until the water table is lowered below the operating mine pit floor. Mineralization usually occurs in areas of significant faulting and fracturing of the rock strata. As a result, mining sometimes intercepts highly permeable zones, with resulting high inflows of water into the excavation area. Pumping is typically in the deeper zones in the bedrock. Where there is a hydraulic connection (no impermeable geologic unit separating the shallow aquifer and the deeper aquifer) between the overlying alluvium and the mined bedrock aquifer, pumping can lower water levels in the overlying alluvial aquifer as well, near the mine.

The shallow aquifer in the area surrounding the mine does not always drop. Often an impermeable or semipermeable layer of clay or silt separates the shallow alluvial and bedrock aquifers. In the Humboldt River Basin in northern Nevada, for example, many of the shallow alluvial aquifers have not declined at the same rate as water levels in the bedrock aquifers, or water levels have remained fairly constant (Maurer and others 1996). Whether shallow aquifers are affected or not during dewatering depends on geologic factors and hydraulic characteristics of the shallow aquifer and the presence or absence of confining layers.

The effects of dewatering may not be evident for several years until the cone of depression deepens and expands beyond the mine area. In the first stages of dewatering, the cone of depression is limited to the mine area. As the pit is deepened and pumping continues and the rate increases, the extent and magnitude of drawdown increases. Sometimes the cone of depression expands to a radius of several miles around the mine and deepens several hundred feet near the mine. The amount of decline and extent of the cone of depression depends on the pumping rate and the physical and hydraulic characteristics of the aquifers intercepted by mining.

The cone of depression may not always be circular. Lateral variations in hydraulic conductivity (permeability) can cause the cone of depression to elongate. Or the cone of depression could extend further in one direction than another, in response to ground water barriers. In strata where transmissivities are low, the cone of depression would be deep but limited in extent. Where transmissivities are high, the cone of depression could be widespread but would typically be shallow. The cone of depression continues to expand for several months or years even after pumping ceases.

Discharge water from dewatering is pumped into holding reservoirs, injected into aquifers, or discharged into existing streams. Regulated by permits issued by the state, these discharges must meet state National Pollutant Discharge Elimination System (NPDES) permit standards. In the Humboldt River Basin, for example, any discharge water pumped into the Humboldt River would be under an NPDES permit.

Dewatering requires high pumping rates. Useful examples of pumping rates required for dewatering can be found at the large open pit gold mines in operation in northern Nevada. For example, total pumpage at the Gold Quarry and Post-Betze Mines, the two largest mines along the Carlin Trend, (north of Elko, Nevada) was 100,000 acre-feet in 1993. Pumpage was projected to increase by another 30% by 2000 and then decrease in later years (Maurer and others 1996). Pumping for dewatering will continue for several years at these mines. At the Lone Tree Mine, 60 miles southwest of the Gold Quarry/Betze Mines, initial pumping rates of 10,000 gallons per minute (gpm) were used, increasing to 25,000 to 30,000 gpm in 1994-95. Pumping rates are expected to increase to a maximum range of 75,000 gpm just before the end of dewatering in 2006 (BLM 1995b).

The U.S. Geological Survey (USGS) studied ground water withdrawals in the Humboldt River Basin, and predicted future ground water declines due to dewatering at mines in 34 hydrographic areas that make up the Humboldt River Basin (Crompton 1995). USGS researchers used a 5-year period, 1995-2000, as the time frame for estimating impacts. These initial assessments can be useful for evaluating cumulative impacts of mining.

The USGS categorized potential impacts by distance from a mine, using local distance (less than 2 miles), areal distance (2 to 6 miles), and regional distance (more than 6 miles). The following estimated drawdown conditions summarize the study.

At the **local distance** water level drawdowns near at least one mine in each of 11 hydrographic areas of the basin may reach a maximum drawdown of 100 feet or greater from 1995 to 2000. In eight other hydrographic areas, drawdowns may potentially reach a maximum of about 20 feet or greater but probably less than 100 feet (Crompton 1995). Some of the local drawdowns have been substantial. For example, at the Post-Betze Mine (as of 1994), water levels declined more than 800 feet beneath an area of about 3 mi^2 near the mine, more than 100 feet beneath about 24 mi^2, and more than 10 feet beneath about 40 mi^2 (Maurer and others 1996).

At the **areal distance** the maximum predicted drawdown of 100 feet or greater decreases to 5 hydrographic areas, and 10 hydrographic areas could have drawdowns of 20 feet or greater, but probably less than 100 feet (Crompton 1995).

At the **regional distance** the maximum predicted drawdown of 100 feet or greater decreases to only one hydrographic area, and three other hydrographic areas are predicted to have drawdowns of about 20 feet or greater but probably less than 100 feet (Crompton, 1995).

The greatest impacts involving water level declines are thus limited to the local area near a mine. But water level impacts are seen across a wide area encompassing several hydrographic areas. The drawdown impacts decrease with increasing distance from the mined area.

Cumulatively, the long-term impacts of dewatering will expand beyond the local areas, so that beyond the 2-mile radius of the mine, drawdowns will become deeper. But predicting the ultimate drawdown at single mines or cumulatively is uncertain because geologic factors can affect the rate of expansion and the ultimate size of the cone of depression, even if the pumping rate stays constant. Cumulatively, mine dewatering can bring about changes in streamflow, springs, fish and wildlife habitat, and agricultural uses. In the Humboldt River Basin, Crompton (1995) estimated that six hydrographic areas had a high potential for change due to mine dewatering from 1995 to 2000.

Effects on Streamflow. Dewatering of aquifers can reduce streamflow either by lowering shallow ground water in alluvial channels along streams or by lowering water levels in deeper aquifers that are hydraulically connected to the stream. Dewatering the alluvium reduces streamflow by eliminating the source of water contributing to streamflow, or by causing streamflow to drain through the stream bottom because of the disconnection between the aquifer and the stream.

This drainage can be substantial if the hydraulic conductivity of the streambed is high and can result in the stream going dry. But in many cases either the streambed has low hydrualic conductivity or a confining clay layer separates the bedrock aquifer and the stream. In these situations, streamflow may not be affected, or the decrease in streamflow could be minimal because the upper aquifer is not affected by the dewatering.

Streamflow can also be affected when discharge from dewatering wells flows directly into an existing stream. Or streamflow can be affected by ground water discharge into the stream from shallow alluvial aquifers that convey the pumped water from the dewatering discharge area to the stream. Bank storage from this mechanism can slowly release ground water into the stream, augmenting the streamflow when streamflow decreases due to climatic factors. Large increases in streamflow from this source can disturb riparian habitat along the stream banks, inundating the riparian vegetation or destroying it by rapidly flowing water under high flow conditions. Fish and certain birds that use riparian habitat could be harmed by streamflow changes.

Effects on Springs. Dewatering does not always result in springs drying up or reduced flows. Because many springs are in mountainous areas and are the result of perched, shallow-flow systems that are not connected to the regional aquifer system, some springs are unaffected by lowered ground water levels caused by dewatering (Crompton 1995). When springs are affected, most of the effects are observed near the mine and the dewatering well field.

Effects on springs can occur several miles away if a spring is supplied by the shallow flow system that is affected by the dewatering. If there is no hydraulic connection between the deep aquifer that is denatured and the overlying shallow aquifer, springs may not be affected at all. Or the decrease in flow could be minimal.

Loss of springflow can also affect wildlife that depend on the water source, and in the case of large springs, riparian habitat may be destroyed.

Effects on Shallow Ground Water. Shallow ground water is expressed by the presence of grasses and shrubs. Generally, water levels less than 15 feet below the ground surface are considered to be in the shallow ground water system (Crompton 1995).

Dewatering effects are more pronounced near mines and typically decrease with increasing distance from mines. Dewatering sometimes affects shallow ground water systems within a radius of a few miles around the mine. But in the Humboldt River Basin water levels in the shallow basin-fill aquifer have not declined at the same rate as in the deeper bedrock aquifer. In some cases, water levels in the shallow aquifer do not changed at all or only slightly change, for example in the area near the Gold Quarry and Post-Betze mines in Nevada’s Carlin Trend (Maurer and others 1996).

Effects on Agricultural Irrigation. Drawdown from agricultural irrigation wells can be significant, ranging to more than 80 feet depending on pumping rates and aquifer conditions. As of 1993, agriculture was the largest water use in the Humboldt River Basin. The effects of mine dewatering could lower ground water levels and increase the costs of pumping irrigation water or require the deepening of wells, which could render irrigation economically infeasible (Crompton 1995).

Pit Lakes. When mining ceases in an open pit being mined below the water table, dewatering is no longer required, and pumps are turned off. Ground water then begins to flow back toward the mine, driven by the hydraulic gradient of the lowered water level at the mine. Several decades may pass before the ground water system approximates premining conditions. As the pit fills, mineral constituents will be leached and transported into the pit with the ground water flow. The ultimate composition of pit lake water quality is variable, depending on the following:

- Host rock for the ore.
- Type of ore deposit.
- Water type.
- Rates of inflow.
- Climatic conditions.
- Reactions between the pit wall and ground water.

Acidic water often results.

Pit lakes may become alkaline in desert environments due to the high evapoconcentration and the low levels of sulfides. Climatic conditions are an important consideration in estimating pit lake water quality. Evapoconcentration in desert environments can change the chemistry of shallow pit lakes. Geothermal water flowing into the pit can cause stratification and overturning of the lake. Reaction with the wall rock is an important factor in determining pit lake water quality (Macdonald and others 1994).

Ground water outside the pit may be affected if the regional hydraulic gradient moves water through the pit and away from the mine. Fluctuations of the water level in the pit can change the direction of flow from or into the pit.

Experience with precious metal pit lakes is limited, especially with deep pits that have only recently been developed. Most of the deep open pit mines in Nevada are still in production and in the process of dewatering (Macdonald and others 1994). Eight pits lakes are now on public lands in Nevada. Pit lakes also form in copper and uranium mining. Water in open pit uranium mine lakes is generally unfit for any use (Macdonald and others 1994).

Ground water quality surrounding many pit lakes is not expected to be affected for several years or decades after pumping stops. The time required for possible impacts to the surrounding ground water quality would vary, depending on the hydrology at the mine site. Normally, ground water flows into the pit for several years after mining. Sometimes decades are needed for the ground water system to reach pre-mining or steady-state conditions. Contaminants do not flow out of the mine pit lake until the hydrologic regime reaches steady state (equilibrium with the flow system). Once steady-state conditions are achieved, ground water might begin to flow out of the mine pit in the direction of the regional hydraulic gradient. At some mines, flow-through conditions can occur early after pumping stops, and the pit is only partially refilled.

Predictions of pit water quality apply geochemical models that use data from laboratory tests of rock content, acid-generating capacity, and hydrologic monitoring data. The following important factors affect water quality in mine pit lakes:

- Pyrite oxidation and acid generation in the pit walls.
- Leaching of metals from wall rock.
- Chemical reactions and evaporative concentration in the water.
- Chemical and oxygen distribution in the final lake.

Water quality in pit lakes changes during filling due to the interaction of pit lake water with different zones of alteration in the pit walls.

Some pit lakes are close to neutral in pH and do not turn acidic. At the Nickel Plate Pit (a gold deposit) near Hedly, British Columbia, for example, the pH of the pit lake is 7.8-8, and the lake has not turned acidic (Macdonald and others 1994). At perhaps the largest expected pit lake in North America, the Betze Pit in northern Nevada, which is an active mine, the final pit water quality is not expected to be acidic (Drever 1991).

Bass planted years ago in the Cortez Mine pit lake in Nevada continue to exist. The fish have no apparent secondary food source, suggesting that the pit lake has enough primary productivity for a food chain that supports the fish (Macdonald and others 1994). But this pit lake is relatively shallow (about 80 feet deep), and conditions differ from deeper pits where lakes will be about 1,000 feet deep.

Several other pit lakes in Nevada are predicted to have water in the neutral range of pH or slightly alkaline. If lakes are alkaline, water quality problems can also develop with elevated levels of contaminants such as arsenic, selenium, molybdenum, vanadium, and nickel.

Attenuation processes can sometimes reduce the contaminants migrating out of the pit. Some studies have shown that attenuation is an important process in reducing concentrations of contaminant plumes but may not always be effective in attenuating all of the contaminants. At the Lone Tree Mine, for example, seepage from the pit lake into the surrounding aquifers is not expected to affect ground water quality because of expected attenuation of the contaminants (BLM 1995b).

Mine pits high in sulfide rock tend to have poor quality water. The pH may be low (acidic) or high (alkaline), depending on the amount of acid-neutralizing and acid-generating capacity of the sulfide rocks. Oxidized mineral zones that contain appreciable amounts of carbonate rock are likely to produce near-neutral pH water quality (near pH 7.0). Because deeper mines are more likely to encounter sulfide minerals, the potential for poor water quality in pit lakes in these deposits is increased.

Water quality in pit lakes can be a transient phenomenon, especially in deep pits. Water inflows in the early stages of refilling can become acidic because of the flow through of sulfide minerals that have oxidized in the pit walls. But as the pit fills, water can encounter acid-neutralizing rock that makes the pH more neutral if the rock has enough neutralizing capacity (Miller and others 1996).

Impacts to ground water down gradient from a mine depend on whether the pit lake is in a flow-through system or a terminal flow system. In a flow-through system, ground water flows into the mine pit and passes out of the pit, migrating down gradient away from the pit lake. In a terminal flow system, the pit captures all ground water that flows within a certain distance of the pit, but water does not pass through the pit. Pit lakes can have terminal flow during filling but then change to flow-through conditions after the pit lake fills to the level of premining hydrologic conditions.

Backfilling of mine pits is one method of reclamation for open pit mining. But backfilling may not always be the preferred option for reclamation where the backfill will be saturated after mine refilling. The resulting water quality might become further degraded because of the leaching of metals and other constituents from the broken and crushed rock in the backfilled material.

Managing the backfilled material (i.e. segregating rock types and placing acid-forming rock types within areas of acid-buffering rock) is important in any attempt to backfill a pit. A full understanding of the regional ground water flow system in mined areas is important so that the ground water flow through closed pits can be more accurately estimated. In addition, backfilling requires an understanding of potential water-rock interactions to predict water quality and pH in the backfilled pit after filling. Whether the water turns acidic is not the only concern. Alkaline conditions can also create water quality problems, with elevated levels of arsenic, molybdenum, uranium, vanadium, manganese, and nickel.

Aquifer Disturbance. Mineral exploration and development can disturb aquifers, but most of the impacts occur during the developing of extraction areas. Open pit and to some extent strip mining removes the permeable geologic strata that may serve as aquifers. Large sections of aquifers can be removed during either open pit or strip mining. Geologic materials can be replaced in the excavation as backfilling material, but the geologic materials would not be the same as in the original aquifer.

Ground water might not flow through these materials as readily as before, or might flow more easily, depending on the material's hydraulic characteristics. As a result, backfilling could disrupt the local ground water flow system and alter ground water flow paths on a local level, possibly changing the ground water regime in the mined area.

Physical Disturbance of Surface Hydrological Systems. Impacts to surface water resources could include the following:

- Changes in water quality.
- Disruptions to the ground water flow system supporting riparian vegetation.
- Changes to stream channel geometry.

Surface water courses are diverted from their historic channels and rerouted around the mine if they cross the proposed mine area. These channels might be replaced after mining is completed through reclamation. But these channels usually do not have the same morphology as the original channel or stream.

The floodplain deposits through which the stream channel passes could affect streamflow characteristics, increasing erosion and changing the frequency and duration of floods. Disrupting the stream channel could destroy the surface water-ground water interaction, harming riparian vegetation.

Acid Rock Drainage. Acid rock drainage (ARD) results from weathering reactions between sulfide-bearing rocks and air and water to generate sulfuric acid. Acid rock drainage is characterized by low pH; increasing acidity; and elevated heavy metals, sulfate, and total dissolved solids in drainage waters emanating from the sulfide rock source. Acid rock drainage can affect water by lowering pH, dissolving minerals, and releasing toxic metal cations (e.g. lead, copper, silver, manganese, cadmium, iron, and zinc). The mobility of heavy metals is also increased in a low pH environment, which allows their transport by ground or surface water. Acidic conditions can be generated in underground mines or in pit lakes formed after open pit mining has ceased.

Acid generation at mines largely results from oxidation of metallic sulfides. The major metallic sulfide of concern is iron sulfide (FeS_2), or pyrite. Other metal sulfides can also contribute to acid generation: galena (lead sulfide), sphalerite (zinc sulfide), and chalcopyrite (iron copper sulfide) (EPA 1997).

Pyrite oxidation is a self-maintaining mechanism. The rate increases with lower pH, which results in the oxidation of more pyrite, generating more oxidation agents, which further lower the pH, continuing the cycle. This process can originate from mine pit walls, mine shafts, tunnels, or waste dumps, and can theoretically continue until all the available sulfide has been oxidized. This process can possibly take centuries or millennia to run to completion (Bird 1993). The reaction process can be slowed significantly by cutting off the water or oxygen supply to the sulfide-bearing minerals.

The oxidation process that generates sulfuric acid normally progresses slowly, but the presence of bacteria can accelerate the process. Biological oxidation enhanced by *Thiobacillus ferrooxidans* and other organisms can increase the oxidation rate by 50 to 1,000 times or more. The time required for acidic conditions to develop depends on the amount and character of the sulfides present, and the alkali minerals available for neutralization (EPA 1996).

The ability of a rock sample to generate net acidity is a function of the relative content of acid-generating and acid-consuming minerals and their size, shape, and distribution throughout the deposit. Typical sediment-hosted precious metal deposits in Nevada contain acid-generating and acid-consuming minerals. The balance between the two determines the extent to which rock-water interaction produces acidic water (Bird 1993).

Recorded pH values from acid rock drainage are as low as *less* than -1.0 (Iron Mountain, CA), but acid rock drainage rarely attains levels below a pH of about 2.0 and typically is in the range of 2.0-4.0 (Bird 1993).

No easy or inexpensive solutions exist to acid rock drainage. Two main approaches to addressing acid generation are (1) avoiding mining deposits with high acid-generating potential and (2) isolating or otherwise special handling wastes with acid-generating potential.

Physical, chemical, and biological controls can be used to prevent, minimize, and treat acid rock drainage. The best environmental controls and the least expensive in the long run are waste management practices that focus on prevention rather than treatment.

Acid rock drainage can be treated using two strategies: (1) active chemical treatment of acid by-products or (2) elimination of acid-generating reactions (SME 1998). For waste piles, the use of covers to isolate the wastes from precipitation and to reduce the interaction of oxygen with pyritic mining wastes is an effective means of slowing the generation of acidic drainage from the waste pile. But this method may not be totally successful, and active treatment may still be needed.

For underground mines, bulkhead seals have been used to minimize oxygen flow into mine workings. Preventing oxygen from contacting sulfide mineralization inside the mine workings can greatly reduce the amount of acid and sulfate products generated (SME 1998). Fractures and fault zones within underground mines can also be grouted to reduce the following:

- The contact of oxygen and water with sulfide mineralization and thus acid generation.
- The volume of water in the mine.
- The chance for leakage through fractures or around the bulkhead.

Although testing methods used to predict acid rock drainage have improved in recent years, the results are often uncertain, and mines can sometimes develop unpredicted acid rock drainage after only a few years.

Tests to predict acid-generating potential may be static or kinetic. Static tests are conducted quickly and are based on determining the balance between acid generation and acid neutralization. Kinetic tests mimic weathering processes in the environment at an accelerated rate.

Kinetic tests should be conducted for at least 20 weeks and might be required for much longer. A year or more in some cases is required to get reliable results. But kinetic tests don't consider the accelerated reaction rates due to catalyzing bacteria and can under predict acid generation. Mineralogy and other factors affecting the potential for acid rock drainage vary from site to site and can result in predictions that greatly differ from what takes place at the mine.

Tailings Impoundments. Tailings impoundments have been used at ore mills in the United States since the early 1900s. In recent years these impoundments have become increasingly important in mining and may account for as much as 20% of the cost of a mine or mill project (EPA 1985). Tailings impoundments do the following:

- Retain water so it can be used in the mill flotation circuits and other processes.
- Serve as equalization basins, which help in the process control of wastewater treatment and

reagent addition control.
- Protect the quality of surface waters by preventing the release of suspended sediment and dissolved chemicals.

Gold tailings impoundments receive cyanidation process wastes; have high concentrations of cyanide, arsenic, cadmium, lead, mercury, and selenium; and are typically alkaline. The strongest indicators of the leakage of tailings ponds into ground water are the presence of constituents added during beneficiation: chloride and cyanide. Tailings impoundments can leak contaminants into ground and surface waters.

Potential effects of cyanide on water resources are related to cyanide's mobility in water. An EPA study of cyanide showed that some forms are mobile whereas others are less so. Transport mechanisms depend on the type of cyanide and the media through which it travels. High pH and low clay content increase cyanide mobility in ground water systems (EPA 1985).

Operations dispose of more than half of all mine tailings in tailings impoundments, whose use is the main method by which tailings are disposed and wastewater is treated. In addition, mining and mineral processing operations typically use settling ponds. The size and design of tailings ponds vary by industry segment and mine location. Some copper tailings ponds in the Southwest cover 600 to almost 1,000 acres, and one exceeds 4,900 acres (EPA 1985). A Bureau of Mines study in 1981 surveyed 145 tailings ponds in the copper, lead, zinc, gold, silver, and phosphate industries. The average size of these tailings ponds is about 500 acres (EPA 1985).

Possible impacts to water resources from tailings ponds include the following:

- Spills due to failure of the tailing impoundment berm.
- Surface water contamination from runoff.
- Seepage of leachate into the ground water.

Leachates that may percolate downward into ground water, such as by leaking from a tailings impoundment, are not specifically regulated by the Clean Water Act (CWA) (because the act excluded ground water) except where this water may contaminate surface water by emerging at springs and seeps (National Research Council 1979).

In two cases (1979 and 1994), however, the courts have interpreted the CWA broadly and held that tributary ground water is protected (Cavanaugh 1998). In an earlier case (1977), the court held that ground water *was not* covered under the CWA. Tributary ground water is ground water that is hydraulically connected to surface water. Thus, ground water in unconsolidated alluvium (sand and gravel) or any aquifer that is hydraulically connected via leakage between an upper aquifer and a lower aquifer may be interpreted as being tributary water.

Such interpretations are left to the courts. (See discussion of tributary water in *Colorado Dept. of Natural Resources* v. *South Western Colorado Water Conservation Dist.*, 671 P.2d 1294, 1300 n. 2 (Colo. 1983).) Case law on this issue is still evolving, and without legislative change to the CWA, the courts will address the issue on a case-by-case basis.

Impacts can result from leakage of tailings ponds used in several mining sectors. EPA studied tailings disposal at eight mines for copper, gold, lead, uranium, and phosphate. Ground and surface water monitoring at each site found evidence of some leakage of solute at most sites. But constituents did not reach concentrations high enough to be of concern, and no evidence was found that the plumes migrated over long distances (EPA 1985).

Revegetation of tailings is inherently difficult, regardless of the ore mined, because tailings are not amenable to supporting higher plants. Water is an extremely limiting factor in revegetation tailings. Where the precipitation exceeds 20 inches, revegetation problems are simplified. But reclamation in the arid West and at high altitudes or high latitudes requires special techniques and comparatively greater effort (National Research Council 1979).

Physical and Chemical Processing Plants. A variety of physical and chemical processes increase the concentration of valuable metal. Operations dispose of the waste material either in waste rock dumps or tailing impoundments.

Spills. Accidental spills of chemicals used in metal extraction and processing could contaminate surface and ground water.

Leachate. Many mines use heap leaching of gold ores to extract minerals from low-grade deposits. For gold and silver heap leach operations, the heap is typically leached with a sodium cyanide solution. Conventional heap leach pads are generally smooth, relatively flat surfaces that are gently sloped in one or two directions to direct the flow of leachate into collection ditches along the pad margins (Buck and Bayer 1989).

Heap leach facilities have leak detection features and sometimes use double liners, often a clay liner and a polyvinyl chloride (PVC) liner. Berms normally surround the facilities to ensure that leachate solutions do not escape into the environment should a heap leach pad fail.

Heap leaching processes present a different set of possible effects to water resources than do mining operations. Seepage of leaching chemicals (e.g. cyanide in base metal flotation and in gold extraction, sodium hydroxide and organic flotation compounds) from heap leach pads or from spills can contaminate ground water. In some hydrologic regions ground water levels are several hundred feet below the surface, and contaminants can greatly weaken before a leak reaches the water table. In many alluvial environments operations must pay special attention to monitoring and preventing the contamination of shallow ground water.

A major hydrologic concern consists of siting heap leach facilities in recharge zones. Some leaching facilities, especially those in the Basin and Range Province, are either in mountainous areas or on alluvial fans along the margins of mountain ranges. These alluvial fans are areas of aquifer recharge (Buck and Bayer 1989). Location of heap leach pads in areas of shallow ground water increases the potential for ground water contamination should a liner leak or the pad itself fail.

Except for system leaks and controlled discharges, spills of cyanide heap leach solutions most often result from the inability of the heap leach system to contain runoff. Interception of precipitation and surface runoff by impoundments containing cyanide decrease cyanide concentrations in the impounded solutions.

A leach solution spill could have disastrous to inconsequential impacts. The effects of a spill depend on many factors, including the type of media into which the spill infiltrates, concentration, pH of the solution, ambient air temperature, and volume and chemistry of the receiving waters (Stanton and others 1986).

Cyanide is a highly reactive and relatively short-lived contaminant (Stanton and others 1986). Several processes are potentially significant in the natural degradation or depletion of cyanide in effluents from many gold processing operations: volatilization, oxidation, biodegradation, photodecomposition, and cyanide-thiocyanate reactions (Stanton and others 1986).

Overall, cyanide can cause three major types of impacts.

- Cyanide-containing ponds and ditches can present an acute hazard to wildlife and birds. (Tailings ponds present similar hazards but less often because of lower cyanide concentrations.)
- Spills of cyanide leaching solutions can enter surface water courses, killing fish and contaminating drinking water sources. Or leaching solutions can enter ground water systems and contaminate water supply wells or discharge contaminated ground water into surface water where streams depend on ground water discharge.
- Cyanide in active heap leaching facilities, ponds, and mining wastes may reach water sources through leaks from leach pads or percolation and runoff from waste piles (EPA 1997).

In addition to other mining contaminants such as acid drainage and toxic concentrations of metals and some nonmetals, cyanide contamination can significantly harm aquatic life. Cyanide is toxic in its free forms, hydrogen cyanide (HCN), and the cyanide ion (CN-), and as breakdown compounds such as cyanates, thiocyanates, chloroamines, cyanogen chloride, and metal-cyanide complexes. No contaminant level criteria have been established for cyanide-related compounds (Moran 1998).

Although free cyanide does not persist in the natural environment and does not bioaccumulate through the food chain, some of the breakdown complexes do bioaccumulate, and some are especially toxic to fish. Consequently, both short- and long-term exposure to excessive concentrations of cyanide and related compounds can kill or impair aquatic life (Moran 1998).

Sediments. The impacts from placer mining and general surface disturbance from exploration and mining include increased organic loading in the stream system from the introducing of overburden sediments or inundating of organic-rich soils. This increase may do the following:

- Produce anaerobic conditions in the sediment.
- Decrease dissolved-oxygen levels in the water.
- Increase color, iron, tannin, lignin, organic carbon, nutrients, dissolved solids, and chemical

or biological oxygen demand.

Regulatory Environment. The Clean Water Act (CWA) (1977) and the Safe Drinking Water Act (1974, amended in 1986 and 1996) mandate that all states adopt water quality standards, which set forth designated uses of waters within their states and numeric criteria to protect those uses.

Section 304(a) of the CWA requires the U.S. Environmental Protection Agency (EPA) to publish and periodically update ambient water quality criteria. These criteria are to accurately reflect the latest scientific knowledge on the following:

- Kind and extent of all identifiable effects on health and welfare, including plankton, fish, shellfish, wildlife, plant life, shorelines, beaches, aesthetics, and recreation that may be expected from the presence of pollutants in any body of water, including ground water.

- Concentration and dispersal of pollutants or their byproducts through biological, physical, and chemical processes.

- Effects of pollutants on biological community, diversity, productivity, and stability, including information on factors affecting rates of eutrophication and organic and inorganic sedimentation for varying types of receiving waters.

These criteria are not rules, and they do not have any regulatory effect. They are criteria and guidelines that can be used to derive regulatory requirements, based on considerations of water quality impacts. The criteria are published in *Quality Criteria for Water*, often called the "Gold Book" (EPA 1986).

On October 18, 1997, the 25th anniversary of the enactment of the Clean Water Act, the Vice President called for a renewed effort to restore and protect water quality. He asked that the Secretary of Agriculture and the EPA Administrator, working with other affected agencies, develop a Clean Water Action Plan that builds on clean water successes and addresses three major goals:

- Enhanced protection from public health threats posed by water pollution.
- More effective control of polluted runoff.
- Promotion of water quality protection on a watershed basis.

On February 19, 1998, the Clean Water Action Plan was released. It set in motion guidance to the partner federal agencies, directing them to coordinate and implement action items to assess, protect and restore watersheds. The plan consists of 111 action items designed to help improve the Nation's water quality. One action item pertains to active mines and states that: "... federal land management agencies and EPA will forge a partnership, consistent with the watershed-based strategy described [in the plan] ... to help resolve issues and enhance review, planning and operations for active mining operations." (EPA 1998). The plan is not a new regulatory program. Rather, it is a set of goals by which states and the federal agencies can cooperatively improve water quality.

The Safe Drinking Water Act established drinking water regulations, setting maximum contaminant levels (MCLs), which are primary standards, and maximum contaminant level goals (MGLGs) for specific contaminants. Whereas MCLs are mandatory and enforceable standards, MCLGs are secondary standards and as such are nonenforceable (40 CFR Part 141). The National Primary Drinking Water Standards, set forth in 40 CFR Part 142, establish drinking water standards that all states must either adopt or have their own standards that are at least as stringent.

The National Secondary Drinking Water Standards are set forth in 40 CFR 143. Mineral operations must meet all water protection standards that have evolved out of these federal laws.

Protecting ground water is mainly a state responsibility. No federal laws deal specifically with ground water although the latest amendments (1996) to the Safe Drinking Water Act address source water protection areas (SWPA) that provide for protecting ground water sources used for drinking water. States are beginning to implement source water protection programs for areas that supply water for public use. These initiatives may be applied to mining if it is conducted near recharge areas for community water supplies.

State regulatory agencies are paying increased attention to water resource concerns. Many states have enacted environmental protection laws since 1990, and many of these laws have mining provisions. Examples include Arizona's Aquifer Protection Permit program begun in 1994 and 1995 and the Mined Land Reclamation Act passed in 1994, and Colorado's Mined Land Reclamation Act, which was significantly amended in 1996.

The state mining and water laws and regulations are constantly evolving in response to increasing regulatory experience in mining and advancing technology, citizen and legislator concern for environmental issues, and the state anticipation of federal action (McElfish and others 1996). But many states do not have programs in place that mimic the National Environmental Policy Act (NEPA). Environmental regulation is handled through specific state programs, focusing on issues or activities, and are often either reclamation-based or water pollution control programs (McElfish and others 1996).

Federal water protection requirements affect state water resource protection laws. For example, a major piece of legislation in Arizona in 1986 created a broad water resource protection law, which adopted the federal water quality standards as the state standard and provided that other water quality standards might be adopted as deemed needed (Arizona Dept. of Mines and Mineral Resources 1998).

The state and federal water protection requirements are used to ensure that mineral activities comply with all standards for water protection. Federal regulations to protect water resources apply to the production of federally owned minerals. These statutes either (1) focus on monitoring to ensure detection of contaminants at existing operations or (2) are aimed at providing protection measures such as creating aquifer protection areas for municipal drinking water wells by employing a buffer zone that precludes development.

Many states have also enacted ground water classification programs to help make decisions on development and protection of water supplies. Some of these programs are not specific to mining but require the overall protection of ground water from contamination sources.

Two pollution prevention programs focusing on ground water are the Wellhead Protection Program (WHP) created by the Safe Drinking Water Act amendments of 1986, and the Source Water Assessment and Protections Programs created by the Safe Drinking Water Act amendments of 1996.

The wellhead protection program directs the states to protect wellhead areas from contaminants that may harm human health. Protection measures include (1) determining areas around public water supply wells that contribute to ground water and (2) managing potential sources of contamination in these areas to reduce threats to the resource. As of April 1, 1999, a total of 47 states and two territories had developed and implemented EPA-approved well head protection programs, and three states are continuing their efforts to develop such approved programs (EPA 1999a). This program may affect mining, depending on the state approach used.

Under the Source Water Assessment and Protection Program, states have developed programs for delineating source water areas for public water supply systems and assessing the susceptibility of the source water to contamination (EPA 1999a). The applicability of this program to mining could vary, depending on how the state approaches the program.

Environmental Consequences

Alternative 1: No Action

Water Quality.

Pit Lakes. Under No Action, after mining is completed, pit lakes could form and take decades to reach their full depth upon equilibrium with the regional ground water system. The number of new open pit mines in the foreseeable future would likely continue at the same rate as during the past 10 years. Potential impacts to water resources could include the following:

- Migration of contaminated water from the pit lake into aquifers down gradient of the pit.
- Discharge of contaminated ground water to the surface through springs or seeps.
- Mortality of waterfowl landing on pit lakes if the lake water is toxic (acidic or alkaline).
- Increased losses of water by evaporation.

Acid Rock Drainage. Water quality could degrade in some areas from development of acid rock drainage from waste rock piles and tailing impoundments, and flow-through leakage from pit lakes. Acid rock drainage would largely be a problem where water quality analysis has not been accurate or mitigation measures have not been successful in preventing it.

Water Quality Not Related to Acid Rock Drainage. Streams would continue to receive some loading of sediments from disturbed areas. Even best management practices would not eliminate sedimentation. Leachate from waste materials might not be acid rock drainage but might still have high level of metals. This leachate might contaminate soils and water.

Surface Water Diversions. Some surface water courses would be diverted from their natural channels where they pass over or near large mines. Many of these diversions would be temporary during mine operations. Others would be permanent because the stream could not be rerouted to the original channel after establishing a new channel with stream dynamics and vegetation.

Spills. Accidental spills of mineral processing chemicals (cyanide) or catastrophic failure of tailings impoundments or heap leach pads could release toxic chemicals into streams and ground water. Most of these unplanned and undesirable events would be short-term impacts and successfully remediated, but sometimes at a high cost, if long-term remediation is needed. These situations are covered by the Resource Conservation and Recovery Act (RCRA) or the Clean Water Act (CWA) if toxic chemicals are released to water.

Leakage from Tailings Impoundments and Heap Leach Facilities. Tailings impoundments and heap leach facilities are expected to leak. But because most facilities employ either leak detection or monitoring systems, leaks would be discovered and remediated. Detection could fail, and leakage could escape. Some constituents could percolate into the ground water below the impoundment and migrate down gradient to water sources, threatening receptors. Most facilities are monitored for up to 30 years after mine closure.

Ground Water Degradation. Polluted ground water might emerge as nonpoint discharges (diffuse springs and seeps) that might not become evident for years after underground mines have closed (after mine filling). Such discharges might be indicators of a widespread contamination plume migrating from the mine.

Water Quantity. Under No Action, impacts would continue from dewatering. Some springs would be lost. Some streams would dry up. Lowered water levels could require some farms to deepen irrigation wells. Ground water levels would take years, perhaps decades, to fully recover from dewatering at the largest mines. Some water levels might never fully recover to premining levels.

Discharge of Pumpage. Water pumped from dewatering could be discharged into existing stream channels. New riparian areas might be temporarily created during dewatering, altering channel morphology. Some aquifers could contain waters naturally high in some constituents such as arsenic. Discharge of waters containing elevated levels of such constituents could migrate down channel into existing waters that meet standards and lower the quality of the receiving waters.

Cumulative Impacts. Under No Action, cumulative impacts to water resources would result from new open pit mines being developed near existing mines. Such a situation is emerging in northern Nevada, where several open pit gold mines are being developed and new mines are in the EIS or planning phase. Other cumulative impacts could result in areas already affected by past mining. New mines in these areas could further degrade water quality of surface streams. On the other hand, new mineral activity in historically degraded areas could actually improve water quality.

Alternative 2: State Management

States are increasingly using water quality-based effluent limits to set their permitting regulations. Some states require design or performance standards, especially for such things as construction standards and liners for tailings impoundments and heap leach pads.

Under the State Management Alternative, water resource impacts would vary due to the wide variation in state-based regulatory mining programs. Only three western states have their own National Environmental Policy Act (NEPA) laws (NRC 1999). Much of the state regulation of mining is under the state reclamation laws, and all western states have enacted these types of regulations (NRC 1999). Some of the mining regulation comes under the purview of the state water pollution laws. Mining will likely have to comply with an evolving set of state standards and regulations that could become more restrictive if states adopt prescriptive standards. State mining regulations and legislation are constantly being updated, mainly due to three factors:

- Increasing regulatory experience and improvements in technology for monitoring and detection.
- Increasing citizen and legislator concern for the environment.
- State anticipation of federal action in the absence of state regulations (McElfish and others 1996).

The expected slight increase in mineral activity (up to 5%) could slightly increase potential impacts to water resources because of the increased number of mines operating. Some states could have decreased impacts to water, depending on the changes in regulations applied to mining.

Alternative 3: Proposed Action

The Proposed Action would not change the existing framework of federal and state laws that protect water resources but would increase protective measures for water resources and reduce the risk of water resource contamination by doing the following:

- Implementing tighter controls on capturing and treating acid rock drainage.
- Managing potentially acid-forming materials (source controls).
- Drilling and grouting exploration holes.
- Collecting baseline data before operation startup.
- Designing leach operations.
- Monitoring water resources.

• Backfilling pits.

These measures would ensure that water resources would be protected to regulatory standards. Periodically, operations would deviate from the standards and would require time to comply with them.

Predicting water quality impacts at mining sites is difficult and involves much uncertainty. Mitigation measures are designed around the uncertainty inherent in predicting water-rock interactions and implementing environmental controls. These measures would continue to protect water resources.

Water Quality.

Surface Water. The Proposed Action would probably reduce the extent of impacts to water resources from mining. The strengthened provisions for water quality protection would help reduce the potential for water quality degradation. Contamination to surface water courses could decline.

Pit Lakes. Mine pit lakes could affect surface and ground water resources. Backfilling open pit mines would slightly reduce impacts from pit lakes. This provision would analyze backfilling and could reduce the number and the size of pit lakes and their impacts on water quality.

Ground Water. Overall, ground water would be better protected under the Proposed Action than under No Action. The effect of backfilling on ground water quality would be highly variable, depending on the type of deposit mined and the effectiveness of segregating the backfill material to prevent the onset of acid generation if this material includes acid-forming waste rock. Overall, the backfilling requirement would be used to reduce impacts to ground water.

The Proposed Action includes requirements to plug all exploration holes to prevent the mixing of water from different aquifers and to prevent movement of water downward into mine workings. These requirements would likely benefit ground water.

Water Quantity.

Dewatering. Under the Proposed Action impacts would continue from dewatering. Some springs would be lost. Some streams would dry up. Lowered water levels could require some farms to deepen irrigation wells. Ground water levels would take years, perhaps decades, to fully recover from dewatering at the largest mines. Some water levels might never fully recover to premining levels.

Discharge of Pumpage. Pumpage from dewatering could be discharged into existing stream channels. Dewatering might create new riparian areas, resulting in altered channel morphology. Some aquifers could contain waters naturally high in some constituents such as arsenic. Discharge of waters containing elevated levels of such constituents could migrate down channel into existing waters that meet standards and lower the quality of receiving waters.

Cumulative Impacts. The dominant water use in many of the mining regions consists of livestock grazing and agriculture. Livestock grazing has required the developing of springs and shallow wells to supply water for livestock. Agricultural uses include high-capacity irrigation wells that may be affected by cones of depression from mine dewatering. The irrigation uses lower water levels in shallow aquifers, but only locally, and often with seasonal fluctuations. Cumulative water resource impacts of mining would continue to be experienced where several mines are permitted in a region, such as in the Humboldt River Basin in northern Nevada.

The most notable impact would be the effect of coalescing cones of depression from dewatering open pit mines that are close to each other. These effects could extend for a radius of several miles. The discharge of pumpage from dewatering several mines could become a serious water management problem that could be compounded by water quality concerns of the discharged water.

Water discharged into streams can change river channel morphology, inundate or destroy riparian vegetation, and disturb fish habitat. Water discharged into reservoirs can percolate into the shallow ground water system and flow to perennial streams, causing increases in flow. Water temperature can increase if the water is discharged directly into streams, harming fish and benthic aquatic organisms.

Alternative 4: Maximum Protection

Alternative 4 would offer the greatest potential for protecting water quality. The provision that all disturbance greater than casual use would require a Plan of Operations would help determine activities that could affect water resources. The use of minimum national design standards for exploration, mining, and reclamation would decrease impacts to water resources. But these standards would increase costs to the industry and increase the workload for the agency in designing standards. Difficulty could arise in implementing some common standards across the West.

The decrease in mineral activity, the more stringent standards, and the unsuitability requirements would all reduce potential adverse impacts to water resources. The requirement of designing all facilities to meet the probable maximum precipitation event could result in decreasing the amount of erosion and sediment from the facility and containing any spills or unplanned events. The requirement that Plans of Operation be renewed every 5 years could help find potential water resource problem areas. Bonding requirements to cover spills and other unplanned events or facility failures could provide a means to mitigate impacts to water resources.

Water Quality.

Pit Lakes. Requirements for pit backfilling would improve water quality at some mines. Eliminating pit lakes would decrease potential impacts to waterfowl if lake water is toxic to such species.

Acid Rock Drainage. Evaluation and control measures for acid rock drainage would strengthen protection for water resources. Restricting operations to no more than 20 years of water treatment would result in applying source control measures to minimize water contamination. As a result, any treatment facilities that might be required as a last resort under Alternative 4 could be built at a smaller scale than under other alternatives.

Water Quantity. The requirement for operators to restore the hydrologic balance within 20 years would prevent long-term impacts to water resources.

Alternative 5: NRC Recommendations

Alternative 5 would generally protect water resources slightly better than would the existing regulations because of the following provisions:

- Exploration in existing special status lands or where more than 5 acres are disturbed would require a Plan of Operations. A Plan would address any water quality or quantity problems that need to be mitigated, and design features would be added to avoid unnecessary or undue degradation of the environment.

- Project approvals would establish acceptable postclosure water quality conditions for pit lakes suitable for long-term use of the site and adequately protecting affected ground and surface waters, as well as wildlife and waterfowl.

Impacts to water resources from acid-forming materials could increase under Alternative 5 because it does not require static or kinetic testing of rock to help recognize and guide the placement of potentially acid-forming materials.

Water resources would be protected in an incremental amount over the existing regulations (Alternative 1).

SOILS

Affected Environment

The National Research Council (1981) defines soil as a discrete, definable, dynamic complex of organic, inorganic, biologic, and geologic materials. Soil forms slowly, beginning with the accumulation of unproductive materials and increasing in productivity with the natural processes of weathering, biological activity, and leaching. Soil's ability to support life depends on its capacity to absorb, store, and transfer energy and water.

Brady (1974) outlined five major soil forming processes as (1) climate, (2) living organisms, (3) parent material, (4) topography, and (5) time. As the soil weathers, a soil profile forms. A profile consists of layers or horizontal units called horizons. These soil horizons can be grouped into four general zones: the O, A, B, and C horizons (Brady 1974).

- The O horizon consists of organic-rich horizons formed above mineral soil, resulting from litter derived from dead plants and animals.

- The A horizon consists of mineral horizons that lie at or near the surface and are zones of maximum leaching or eluviation.

- The B horizon, sometimes referred to as the subsoil, consists of horizons in which illuviation (deposition from one horizon to another) from above contributes to an accumulation of such materials as iron and aluminum oxides and silicate clays, or in arid regions, accumulations of calcium carbonates or calcium sulfate.

- The C horizon consists of the unconsolidated material underlying the A and B horizons and may or may not be the same as the parent from which the A and B horizons formed. The C horizon usually lies outside the zones of major biological activity and is little affected by soil-forming processes.

A soil profile is characterized by the sequence and development of the horizons described above. These horizons normally can be distinguished from one another by their texture, color, structure, and organic matter content. Under the Comprehensive Soil Survey System, the soil profile can be classified into one of 10 broad classifications called soil orders (Brady 1974). Within the EIS study area are 10 major soil orders: Andisols, Aridisols, Entisols, Inceptisols, Mollisols, Ultisols, Alfisols, Histosols, and Spodosols.

- **Andisols** formed under the strong influence of volcanic ash. They are often erosive and found mostly in forested areas.
- **Aridisols** developed in dry regions and are usually light colored and low in organic matter. They may have accumulations of sodium, soluble salts, and lime. Desert shrubs, sagebrush, and pinyon-juniper plant communities commonly grow on Aridisols.
- **Entisols** are relatively young soils formed in recently deposited materials. They therefore have little soil profile development.

- **Inceptisols** are also young soils that have undergone more weathering and soil-forming processes than Entisols. Inceptisols are common in coniferous and deciduous forests.
- **Mollisols** have a thick, dark colored surface horizon rich in organic matter and are most abundant in prairie grasslands.
- **Ultisols** occur on stable surfaces that have undergone advanced soil development resulting in the accumulation of a clay-rich subsurface horizon. Ultisols are usually found in forests.
- **Alfisols** also exhibit clay accumulation within the soil profile and are most common in coniferous and deciduous forests at higher elevations and in mountain shrub communities.
- **Histosols** contain at least 50% organic matter in the upper 32 inches of their profile and occur within riparian areas, seeps, and bogs.
- **Spodosols** are mineral soils with a subsurface horizon having an accumulation of organic matter. Spodosols are common along coastal areas of Alaska and support Sitka spruce and western hemlock.

Since the inception of the 3809 regulations in 1981, exploration and mining have disturbed about 214,000 acres of public lands, including the soils on them. Except for placer mining, most of this disturbance has taken place within the western contiguous states, predominantly on Aridisols and Mollisols. The bulk of placer mining on public lands has occurred in stream channels in Alaska, disturbing mainly Entisols. Of the 214,000 acres disturbed by mining under the 3809 regulations, 65,000 acres have been reclaimed. The remaining 149,000 acres yet to be reclaimed are still part of active mining operations and, except for open pits not backfilled, will eventually be reclaimed.

Reclamation in the early 1980s consisted mainly of grading to gentler slopes followed occasionally by seeding. Attempts at salvaging topsoil were inconsistent. Disturbed areas were often revegetated directly on the regraded surfaces of waste rock, tailings, or heap leach material. Through the mid-1980s, as larger mines were proposed, it became a more common practice to conduct soil surveys and salvage the soil surface–the O and the A horizons–commonly known as topsoil, for later use on the reconstructed surfaces.

Between 6 inches and 2 feet of topsoil are typically salvaged except where bedrock is close to the surface or surface accumulations of salts or sodium inhibit plant growth. Where topsoil is lacking or unsuitable, reclamation is still undertaken directly on the reconstructed surfaces. Soil amendments such as mulch and fertilizer may be used to minimize erosion and improve the fertility of the reconstructed surfaces for vegetation. Reclamation plans generally address issues involving postmining physical and chemical characteristics of the soils on particular sites.

For placer mining, the surface layer of soil, where it exists in enough quantity, is usually stripped and used later for reclamation. But the bulk of placer mining on public lands has taken place within Alaska, and many of these areas have been already mined in the past. Soils that may have been there have since been mined through and lost. Larger placer mines are usually reclaimed by regrading tailings and coarse rock stockpiles to re-create the channel and flood plain. Vegetation is then allowed to become established by natural succession. Placer mining usually occurs within the confines of a drainage system. Over time, especially during high flows, the drainage reworks the loose material and establishes a new floodplain.

As the reclamation program for the 3809 regulations has evolved, many western states also began to institute mine reclamation programs of their own, on private as well as the public lands. (See Appendix D for a summary of state mine reclamation programs.) Many of these state reclamation programs were developed at about the same time as the existing 3809 regulations, and they often mirrored and reemphasized BLM's reclamation programs.

Environmental Consequences

Impacts Common to All Alternatives

Mining typically follows a logical sequence, starting with exploration and proceeding to extraction when economic deposits are found. Impacts of this sequence on soils range from dispersed and negligible during early exploration to more local and intense as mineralization and ore deposits are defined and mined.

With mining, disturbance is nearly total as the soil profile is destroyed either by excavation or burial. The National Research Council (1981) summarized the effects of soil disturbance by mining as generally more adverse than advantageous because many beneficial soil characteristics require hundreds to tens of thousands of years to reach steady state.

Disturbance, however, may actually increase a soil's productivity where mining breaks up a restrictive hardpan or where replacement of sodium or salt-affected soils results in greater plant growth (National Research Council 1981; Schafer 1984).

Because only the topsoil is usually salvaged and stockpiled for later reclamation, the loss of the rest of the soil profile is almost always irreversible, including, whatever forces these deeper horizons played in favoring the growth of one plant over another or one plant community over another.

Reclamation of mine disturbances, either concurrent with mining or after closure, customarily involves grading slopes to less steep angles, applying topsoil, and revegetating. Except for open pit mining, most mining disturbances can be reclaimed to vegetation that is adapted to the reconstructed surface and new soil regime. Most often, however, the newly reconstructed soil would resemble a younger soil, such as an Entisol, with little soil profile development.

Alternative 1: No Action

Under the existing 3809 regulations topsoil is salvaged and stockpiled for reclamation use later. Upon final reclamation, slopes are usually graded to blend with the surrounding topography, topsoil is reapplied, and new surfaces are seeded. The main emphasis of this reclamation has been on establishing a productive cover of perennial plants roughly equal to what exists next to the mine disturbance. To this end, mine reclamation has been fairly successful (Ross 1996). In Alaska, vegetation cover is generally allowed to come back naturally following grading and reapplying topsoil.

The exceptions to the salvaging of topsoil occur under the following conditions:

- The soil has been lost due to past mining.
- Little soil exists to strip because of thinness to bedrock or a hardpan.
- The surface has chemical or physical properties that inhibit plant growth.

In these latter cases, materials (waste rock, tailings, or heap leach material) left on the surface after regrading are reclaimed. Problems may occur, however, where the reconstructed surfaces of waste rock, tailings, or heap leach material are also harmful to or unsuitable for plant growth for physical and chemical reasons. Soil amendments such as mulch and fertilizer may be added to improve the fertility of the new surface. But the new soil might not be able to support the same plants or diversity of plants as before.

Alternative 2: State Management

Except for small disturbances, all the states in the study area have some form of program in place for reclaiming mining disturbance. For activities involving less than 3 to 5 acres of surface disturbance, states like Arizona, Alaska, Montana, Nevada, and Washington do not require operators to notify state authorities of surface-disturbance or reclamation, even though reclamation is required. Without oversite, some of these small-sized projects would not receive the same level of reclamation as they might under the existing regulations where notification is required.

State requirements for salvaging and reapplying topsoil upon reclamation are similar to BLM's existing 3809 regulations, but state agencies are usually staffed at much lower levels and may lack their federal counterpart's resources in administering the mine reclamation program. State agencies are usually located in one central place in contrast to BLM, which has field offices spread throughout the state nearer the mining activities and public lands they manage. BLM offices also have reclamation specialists and soil scientists whose expertise would ensure that soil resources are salvaged for final reclamation. Because of the state's reduced oversite, less topsoil may be salvaged by the operator or safely stockpiled from the impacts of future mine disturbance under Alternative 2 under BLM management under the existing regulations or proposed alternatives.

Alternative 3: Proposed Action

The Proposed Action requires the use of replacement soil where the topsoil is of poor quality. Under the existing regulations, typically only the surface horizons or topsoil is salvaged and stockpiled for reclamation use. In most cases, the topsoil provides the most desirable growth medium for plant growth. But in some cases the topsoil itself is harmful to plant growth because of accumulations of salt or sodium, or where the volume of topsoil itself may be limited because of shallow depth to bedrock or a hardpan. In these cases, salvaging and stockpiling overburden or waste rock with desirable characteristics for replacement growth medium would promote better revegetation than under the existing regulations.

Mining can lead to accelerated soil erosion, where the surface is disturbed and vegetation has been disturbed or removed. The Proposed Action requires that erosion be minimized through grading of reclaimed slopes to gentler contours followed by revegetation to hold the soil in place. This requirement should lead to less soil erosion than under the existing regulations, Alternative 2, or Alternative 5.

Under the Proposed Action, all mining projects would require Plans of Operations, resulting in a more formal review and approval of activities. This review and approval would ensure that more soil is salvaged and conserved for final reclamation than under the existing regulations.

The Proposed Action would require reclamation bonds for all Notices. This financial assurance would prompt better compliance by the operator with reclamation measures than under the existing regulations, including the salvaging and stockpiling of topsoil and its use in final reclamation of the site.

Alternative 4: Maximum Protection

Alternative 4 would require that subsurface horizons as well as the soil surface be salvaged and stockpiled. Compared to the other alternatives, this requirement to salvage more of the soil profile and return it near its original vertical order on the reconstructed surface would promote easier restoration of the site to the same native plants and plant community that grew there before mining.

Alternative 4 would also require that all operations have Plans of Operations, resulting in a more formal review and approval of activities. This review and approval would ensure that more soil is salvaged and conserved for final reclamation. Alternative 4 would also require operators to hire third-party contractors to monitor operations, and this greater on-the-ground presence of monitors would ensure that the proper depth and volumes of soil are salvaged and stockpiled according to the reclamation plan.

Alternative 4 would require that all final slopes be graded to 3 to 1 (horizontal to vertical). This requirement would result in less soil erosion than any other alternative and would facilitate better revegetation. The standard, however, would be impossible to apply where the natural terrain is steeper than 3:1, which is common where mining occurs.

Alternative 5: NRC Recommendations

Under Alternative 5 all mining projects would require Plans of Operations, resulting in a more formal review and approval of activities and ensuring that more soil is salvaged and conserved for final reclamation than under the existing regulations. The requirement for the bonding of all Notice-level operations would also give more assurance that disturbed areas are reclaimed than could be given by the existing regulations or Alternative 2.

Alternative 5 would require reclamation bonds for all Notice-level operations. Compared to the existing regulations, this financial assurance would prompt better compliance by the operator with reclamation measures, including, the salvaging and stockpiling of topsoil and its use in reclaiming the site

Cumulative and Residual Impacts to Soil Resources

An estimated 214,000 acres of public lands were disturbed by exploration and mining in the first 18 years after the 3809 regulations went into effect in 1981. Projections for mineral activities over the next 20 years show that surface disturbance under the existing regulations and alternatives would disturb as much as 183,000 more acres. The total surface disturbance on soil resources from past and reasonable foreseeable mineral activities over 20 years, therefore, would equal as much as 400,000 acres. This amounts represents about 0.12% of the total acreage of public lands and Stock Raising Homestead Act lands administered by the BLM within the study area (see Table 3-1). The cumulative impact from mining activities on soil resources within the study area is therefore rather limited.

The 400,000 acres disturbed by mining would undergo long-lasting residual impacts. Even though most of this disturbance would eventually be reclaimed, mining destroys the original soil profile by excavation or burial. A soil profile ordinarily requires hundreds to tens of thousands of years to develop. Because only the surface or topsoil is usually salvaged, the loss of the remaining profile constitutes a near irreversible commitment of these soil resources. Alternative 4 would require more of the soil profile to be salvaged, resulting in less of a commitment of these soil resources then the other alternatives.

Typically, topsoil is stockpiled for long periods in open-pit operations and begins to lose fertility. Due to a lack of oxygen, soils buried under a few feet would begin to lose the microfauna and flora that are important in nutrient cycling. At the same time, seeds stored in the buried topsoil also begin to lose their viability, and the benefits of the soil as a native seedbank are diminished.

Once reclamation is completed, however, any micro-fauna and flora still viable in the topsoil would begin to spread or volunteer from outside onto the site. Conceivably, within a few years to decades, the surface soil should begin to approach the surrounding, undisturbed areas in organic matter content and presence of microfauna and flora. If left undisturbed, cryptogamic crusts might also begin to reestablish within the same time frames.

VEGETATION

Affected Environment

The pattern of vegetation in North America has fluctuated widely in the past 10,000 to 12,000 years, following the melting of the continental glaciers. During the postglacial period the climate was notably warmer and drier than today. The boundaries of the forests and shrub-like grasslands have fluctuated accordingly (Mehringer and Wigand 1987), as have the boundaries of other drier-site plant communities. Still, the types of plant communities that will grow on a site are dictated most often by the site's soil type, its topographic position, and the area's climate.

Plant community types within the EIS study area can be divided into the following broad groups: sagebrush, desert shrub, southwest shrubsteppe, chaparral-mountain shrub, pinyon-juniper, mountain and plateau grasslands, plains grasslands, annual grasslands, alpine grasslands, coniferous and deciduous forests, riparian communities, coastal forests, boreal forests, lowland tundra, and upland tundra. This section briefly discusses all of these groups except for riparian communities, which are discussed in the Riparian-Wetland Resources section of this chapter. For a more complete description of most of these plant community types, see the *Rangeland Reform '94 Draft EIS* (BLM 1994a).

Sagebrush

Within the upper and lower basin and range provinces, the Colorado Plateau, the Columbia Plateau, and the Wyoming basins, sagebrush often dominates dry slopes and lava bed flats, ancient lakebeds, and broad alluvial basins. Most of the sagebrush zone is found at elevations from 2,000 to 7,000 feet. Where sagebrush dominates below 7,000 feet, annual precipitation varies between 8 and 20 inches (Wright and others 1979).

Important shrubs include big sagebrush, black sagebrush, low sagebrush, rabbitbrush, Mormon tea, curly leaf mountain mahogany, bitterbrush, snowberry, and horsebrush. Important perennial grasses include Sandberg bluegrass, blue bunch wheatgrass, western wheatgrass, Idaho fescue, Great Basin wildrye, junegrass, Indian ricegrass, squirreltail, muttongrass, and needle-and-thread grass. Red brome, medusahead, and cheatgrass are introduced annual grasses that have become abundant. Common forbs include wild onion, sego lily, balsam root, mulesear, Indian paintbrush, larkspur, tarweed, rubberweed, lupine, phlox, locoweed, and annual mustards (Cronquist and others 1972).

Desert Shrub

Desert shrub communities occupy the hot and cold deserts of Arizona, Nevada, Utah, and California. These deserts are dominated by shrubs in open stands, with large amounts of bare soil or desert pavement exposed. Understory vegetation is often sparse at lower elevations except when flushes of annuals are produced by seasonal precipitation in the Mojave and Sonoran deserts.

Desert plants have adapted to harsh growing conditions, which include root systems of some shrubs that can access deep soil moisture, as well as, shallow roots that extend laterally some distance and compete with herbaceous vegetation for surface moisture. Plants such as cacti and other succulents have special tissue in their stems or leaves to store moisture and limit moisture losses by minimizing transpiration. Annuals germinate, mature, and produce seeds only during favorable temperatures and moisture conditions, often within a single season. Desert plants have also adapted to drought caused by high soil salinity or alkalinity by removing excess salts from their tissues and regulating salt uptake from their roots.

Southwest Shrubsteppe

The southwest shrubsteppe vegetation zone occupies the semidesert grasslands of southeast Arizona, southern New Mexico and the northern Chihuahuan Desert. Elevations of the semidesert grasslands range from 3,300 to 5,000 feet (Brown 1985). More than half of the 10 to 20 inches of annual precipitation falls during the summer growing season (Benson and Darrow 1981). Semidesert grasslands are best developed on deep, well-drained soils at level sites on the higher plains. Their aspect is a grassy landscape broken up by large, well-spaced shrubs. In the Southwest, semiarid grasslands often form an alternating landscape mosaic with Chihuahuan desertscrub.

Large areas of this grassland are dominated by mesquite, tarbush, acacia, and creosotebush. Black grama and tobosa are the most characteristic grasses. Other important grasses on the better sites include sideoats grama, hairy grama, bush muhly, vine mesquite, Arizona cottontop, slim tridens, pappus grass, tanglehead, threeawns and curly mesquite. Other shrubs and succulents characteristic of this grassland include yuccas, bear grass, sotol, agaves, allthorn, sumac, hackberry, ocotillo, acacias, and mimosas. Many variations of cacti grow in the drier sites, especially on outcrops.

Chaparral-Mountain Shrub

The chaparral-mountain shrub vegetation type occupies foothills, mountain slopes, and canyon habitats ranging from southern Oregon to the Mexican border, and from sea level to more than 5,000 feet. Chaparral-mountain shrub communities typically consist of dense to moderately opens stands of evergreen shrubs that grow to roughly uniform height. Most chaparral shrubs are deep rooted, sprout readily from the root crown, and regenerate quickly after burning (Brown 1982).

Canyon live oak is a common dominant of the interior chaparral. Associated shrubs include manzanita; mountain mahogany; yellowleaf silktassel; sumac; hollyleaf buckthorn; chamise; red shank; and several sophora, ceanothus, and other oak species. Important grasses include sideoats and hairy grama, cane bluestem, plains lovegrass, threeawns, and wolftail. These grasses are largely confined to recently burned areas and rocky, protected sites. Forbs are not particularly abundant except during brief periods after burns (Brown 1982).

Pinyon-Juniper

The pinyon pine and juniper vegetation type grows at mid-elevations on mountain slopes within and next to the Great Basin. This is a cold-adapted evergreen woodland with the unequal dominance of two conifers, junipers and pinyon pine. The pinyon-juniper woodland reaches its greatest development on mesas, plateaus, slopes, and ridges from 3,200 to 8,400 feet (Blackburn and Tueller 1970; Evans 1988). Precipitation ranges from 10 to 25 inches annually (Blackburn and Tueller 1970). Pinyon-juniper communities survive on a wide variety of soils, ranging from shallow to moderately deep and from coarse and rocky to fine compacted clays.

Rocky Mountain juniper, Utah juniper, and oneseed juniper often grow together (Cronquist and others 1972). In the dry mountains of southern New Mexico and below the Mogollon Rim in Arizona, Rocky Mountain juniper, Utah juniper, and doubleleaf juniper disappear, and alligator juniper (a sprouting variation of juniper), Emory oak, gray oak, and Mexican pinyon appear (Brown 1982). The associated understory of shrubs, grasses, and forbs in juniper communities commonly consists of a variety of vegetation from sites near woodland communities.

Mountain and Plateau Grasslands

The mountain and plateau grasslands are located at moderate to high elevations (3,000 to more than 9,000 feet) in the West. These grasslands often occur within a vegetation mosaic created by the complex environment of the Rocky Mountains. The grasslands ecosystem receives from 8 to 30 inches of precipitation annually (Garrison and others 1977; Mueggler and Stewart 1980), at least half of it usually falling during the growing season. The topography of mountain and plateau grasslands ranges from level areas or valley floors to alluvial benches and foothills or steep mountain slopes.

Important grasses in mountain and plateau grasslands include grama grasses, bromes, bluegrasses, oatgrasses, sedges, wheatgrasses, fescues, needlegrasses, and Junegrass. Diverse throughout the region, the forb component varies with the site, latitude, and management. Shrubs include fringed sagebrush, rabbitbrushes, snakeweed, shrubby cinquefoils, wild roses, and horsebrush (Mueggler and Stewart 1980).

Plains Grasslands

The plains grasslands vegetation type is found in the Great Plains, stretching from eastern Montana, North Dakota, and Western Minnesota southward to eastern New Mexico and Texas. The western half of the plains grassland forms a broad, flat belt of land sloping gradually eastward from the foothills of the Rocky Mountains. Mixed and shortgrass communities are most commonly found on federal lands within this vegetation type.

The short grasslands communities stretch from southeast New Mexico through eastern Colorado to southeast Wyoming. Annual precipitation ranges from 11 to 20 inches, and elevations range from 6,000 feet on the western edge to 3,000 feet on the southern edge. Dominant grasses are buffalograss and blue grama, with smaller amounts of threeawns, lovegrass, tridens, sand dropseed, sideoats grama, tobosa, galleta, vine mesquite, and bush muhly. Forbs are seldom a major component, except during wet years. Dominant woody plants include honey mesquite, shinnery oak, sand sagebrush, snakeweed, yucca, fourwing saltbush, cholla, and prickly pear.

The mixed grass communities stretch from northeast Wyoming through North and South Dakota and eastern Montana. Precipitation varies from 20 to 28 inches, increasing from west to east. Elevation ranges from about 3,000 feet at the western edge to 900 feet in Texas (Wright and Bailey 1980). Sedges and cool-season grasses, such as needlegrasses, wheatgrasses, and fescues, dominate the communities of Montana and North and South Dakota. Warm-season grasses, particularly blue grama, also grow in mixed grass communities and increase in dominance to the south.

Other important grasses in mixed grass communities include green needlegrass, prairie sandreed, needle-and-thread grass, junegrass, sand dropseed, buffalograss, sideoats grama, threeawns, silver beardgrass, sand bluestem, little bluestem, plains lovegrass, and vine mesquite (Brown 1982). Shrubs found in mixed grass communities include juniper, sand sagebrush, silver buffaloberry, sumac, wild rose, rabbitbrushes, yucca, snakeweed, cholla, and winterfat (Brown 1982; Mueggler and Stewart 1980). Forbs may be an important component of mixed grass communities. Common forbs include goldeneye, groundsel, sunflowers, primrose, globemallow, asters, scurf pea, coneflower, and bricklebush (Brown 1982).

Annual Grasslands

Annual grasslands occur in California, especially, on small plains and gently rolling hills scattered throughout southern California, the Central Valley, and in the coastal mountains as far north as Humboldt County. Annual grasslands grow at elevations ranging from sea level to 4,000 feet. Relicts of the pristine California prairies are found within small parcels of annual grasslands.

Fall rains cause the germination of the annual grassland plants that grow slowly during winter and then grow rapidly in the spring as temperatures rise. Dominating annual grasslands are such introduced annual grasses as wild oats, soft chess, ripgut brome, red brome, wild barley, and foxtail fescue. Common forbs include redstem filaree, broadstem filaree, turkey mullen, true clovers, and burr clover. Perennial grasses that are found in moist, lightly grazed or relict areas include Idaho fescue and purple needlegrass.

Alpine Grasslands

Beginning at the upper limits of tree growth, alpine plant communities extend upward to the exposed rocks of mountain tops. Alpine communities have similar combinations of vegetation throughout, including, phlox, clovers, alpine avens, yarrow, alpine sedge, alpine bluegrass, elk sedge, spikerush, and tufted hairgrass. The willow communities typically consist of alpine willow, barren ground willow. Tealeaf willow, and snow willow. Alpine meadow communities grow on sheltered benches, slopes, and level areas where soils are well developed. Alpine marshes replace ponds or develop wherever springs and melting snowbanks contribute to a continuously moist habitat.

Coniferous and Deciduous Forests

Coniferous and deciduous forests grow in the Rocky Mountains; the Sierra Nevada; the Cascade Range; and the mountains of the upper and lower basin and range provinces, the Colorado Plateau, and the Columbia Plateau. Species dominance varies by altitude, latitude, slope, aspect or other topographical position, soil characteristics, and climate regime. Important forest communities of the western rangelands include ponderosa pine, Douglas-fir, aspen, lodgepole pine, hemlock-spruce, cedar-hemlock, spruce-fir, redwood, and western hardwood.

Ponderosa pine is the largest western forest, and old-growth ponderosa forests are often park-like, having old trees interspersed within groups of young trees and a well-developed herbaceous understory. Douglas-fir communities are found from the northern portion of the California Coast Range, through Oregon and Washington, and throughout the Rocky Mountains, generally between the ponderosa pine and spruce-fir communities (Wright and Bailey 1982).

Cedar-hemlock forests grow in northern Idaho and northwest Montana, where the westerly winds carry oceanic influence as far inland as the Continental Divide. Douglas-fir and western white pine are common associates. Understory in this zone consists of a rich growth of shrubs and herbs (Wright and Bailey 1982).

Hemlock-spruce communities extend south from British Columbia along the Washington and Oregon coasts and a portion of the Cascade Mountains in Washington. Elevations range from 200 to 4,000 feet. The dominant species are Sitka spruce and western hemlock. Western red cedar, Douglas-fir, and grand fir may also be present to a lesser degree. Common understory plants include vine maple, red whortleberry, Cascades mohonia, twin flower, California dewberry, coast rhododendron, holly fern, and cutleaf fern. The dense overstory reduces production.

Lodgepole pine grows mainly in the central and northern Rocky Mountain of Colorado, Wyoming, Montana, Utah, Idaho, and Oregon. It is also found in the higher mountains of southern California. Lodgepole pine tends to dominate its communities, often forming dense, pure stands with little understory. The understory can vary from being virtually absent to a rich herbaceous layer next to meadow edges. Often invading riparian habitats, lodgepole pine can have a substantial understory of bitterbrush, Idaho fescue, needlegrass, oatgrass, and wildryes.

The spruce-fir community has open to dense evergreen forests and patches of shrubby undergrowth with scattered herbs. Composition of the overstory varies widely but is usually dominated by some combination of red fir, Engelmann spruce, subalpine fir, mountain hemlock, white bark pine, western white pine, lodgepole pine, foxtail pine, limber pine, and bristlecone pine.

The redwood community is a composite name for a variety of mixed conifers that grow within the coastal influence: Sitka spruce, grand fir, redwood, Douglas-fir, and red alder. The redwood community is restricted to the coastal areas of California and southern Oregon.

Western hardwood communities, sometimes called oak woodlands, grow in California and the western interior valleys of Oregon, especially the foothills surrounding the Central Valley and coastal rangelands in California and the Willamette, Umpqua, and Rogue River valleys in Oregon. Trees in these communities include Oregon white oak, Coulter pine, digger pine, coast live oak, blue oak, valley oak, and interior live oak.

Coastal Forests

Coastal forests occupy the south and southeast coasts of Alaska and are dominated by closed and open evergreen forests, mainly Sitka spruce-western hemlock. Closed and open deciduous forest are rare and limited mainly to stands of black cottonwood or red alder on floodplains, streamsides, and recently disturbed sites. Woodland lodgepole pine communities grade into bog types on poorly drained sites. On coastal deltas extensive areas of sedge and grass wet meadows are common (Viereck and others 1992).

Boreal Forests

Occupying vast areas of interior Alaska, boreal forests are dominated by closed, open, and woodland evergreen forest of black and white spruce, but have extensive areas of open and closed deciduous forest of paper birch, aspen, and balsam poplar. Within this vegetation zone are extensive mosaics of shrub and herbaceous types, including extensive areas of subarctic lowland sedge and sedge-moss bog meadows as well as willow, sweetgale, and graminoid bogs (Viereck and others 1992).

Lowland Tundra

The dominant vegetation of the lowland tundra consists of wet sedge meadow interspersed with many lakes. The lowland tundra occurs mainly on the coastal plain of northern Alaska and in the low lying deltas and other coastal areas in western Alaska (Viereck and others 1992).

Upland Tundra

Over much of arctic and western Alaska the upland tundra is dominated by *Eriophorum vaginatum* tundra with areas of *Dryas* dwarf shrub tundra on exposed ridges and dry rocky sites. In mountainous areas above treeline, *Dryas* dwarf and ericaceous shrub tundra are the most widespread plant communities. In many areas in western Alaska and in most areas near treeline in the Alaska and Brooks ranges, the zone includes extensive areas of shrubland, mainly low shrub dwarf birch. On the Aleutian Islands, the most widespread community is *Empetrum* heath, but extensive areas of dry and mesic graminoid herbaceous vegetation also occurs (Viereck and others 1992).

Threatened, Endangered, and Candidate Plant Species

The Endangered Species Act of 1973 was passed to conserve threatened and endangered species and the ecosystems on which they depend (see Appendix C). Under the act, species are classed as threatened, endangered, proposed, or candidate species. Endangered plant species are listed because they are in danger of extinction throughout all or a significant portion of their range. Threatened species are those likely to become endangered within the foreseeable future throughout all or a significant portion of their range. Proposed species are those for which a proposed rule to list as endangered or threatened has been published in the *Federal Register*. Candidate plant species are on file with the U.S. Fish and Wildlife Service as vulnerable but where further action is precluded by higher priority listing. To date, about 129 plants are listed as federally endangered or threatened plant species on BLM administered lands (see Appendix F).

Impacts of Mining

The 43 CFR 3809 regulations first took effect in 1981. From 1981 through 1998, mineral exploration and mining disturbed 214,000 acres. Except for placer mining, much of this land has been disturbed within the western contiguous states, mostly in the sagebrush, mountain grasslands, pinyon-juniper, prairie grasslands, and southwestern shrubsteppe plant community types. Miners have extracted placer deposits on public lands predominantly within stream channels in Alaska, disturbing mainly riparian vegetation (discussed in the Riparian-Wetland Resources section of this EIS).

Many plant communities disturbed by mining under the existing regulations were within historic mining districts that had themselves been affected by past mining in addition to other activities such as livestock grazing and range seedings. As a result of these past disturbances, weeds have invaded many areas.

Of the 214,000 acres disturbed under the 3809 regulations, 65,000 acres have been reclaimed so far. Except for unbackfilled open pits, the remaining acreage will eventually be reclaimed as these active operations reach closure. Reclamation under the existing regulations has evolved since 1981 as the experience and knowledge of operators and BLM have grown. At the same time, many western states have developed mine reclamation programs in coordination with BLM.

In the early 1980s reclamation consisted of limited grading followed occasionally by seeding. Disturbed areas were often revegetated directly on regraded surfaces of waste rock, tailings, or heap leach material. Beginning in the mid-1980s seeding became a more common practice. It is standard practice now to salvage topsoil and seed disturbed areas.

Operators conducted early seedings using a diverse seed mix upon final reclamation. Early seedings consisted mostly of grasses developed for livestock grazing and known for their drought tolerance and success in establishing itself under a variety of circumstances. Grasses such as crested wheatgrass (*Agropyron cristatum*) were extensively used because seed could be obtained in commercial quantities, established easily, and stabilized disturbed areas. This practice more recently has shifted to seedings using a diverse mixture of native grasses, forbs, and shrubs.

Over the last several years BLM has incorporated more rigorous requirements for monitoring revegetation success, as in Nevada where the perennial plant cover of reclaimed areas is compared to adjacent, undisturbed reference areas. Ross (1996) evaluated the reclamation success of mine disturbances on public lands in Nevada and found that in most cases total perennial plant cover of reclaimed areas equaled and often exceeded the cover of adjacent undisturbed reference areas.

Environmental Consequences

Impacts Common to All Alternatives

Most mine disturbance has and is expected to continue to take place on public lands within Nevada, Montana, California, Arizona, Idaho, Utah, and Alaska, and would affect the sagebrush, desert shrub, pinyon-juniper, and southwest shrubsteppe plant communities. Little mining has or is expected to occur on public lands within coniferous and deciduous forests

Except for open pits and arctic, alpine, and desert environments, which are among the most fragile and slowest to recover from disturbance, most mining disturbances can be reclaimed to vegetation that is adapted to the reconstructed surface and new soil regime.

Upon final reclamation, the classic view of ecological succession holds that a series of plant assemblages will progressively occupy a site following a disturbance. Each plant assemblage is then replaced by a successor until the final climax community is reestablished. Where the goal has been to restore the predisturbance ecosystem, a typical management strategy is to hasten the rate of succession by planting late seral species in the hope that the vegetation will continue quickly toward the premining plant community. The plant community that does establish on the reconstructed surface may well approximate the plants that grew there before. Chances are, however, the site will greatly differ from premining conditions, and a different plant community or potential will become established.

Drastic disturbances such as mining may yield substrates that dramatically differ from those before disturbance. Such differences may affect the rate of succession, chronically altering its direction (Schafer 1984). Different trajectories of succession are therefore possible because of different initial conditions relative to premining conditions following reconstruction and reclamation (Allen 1988). For example, in Nevada shallow-rooted low sagebrush (*Artemisia arbuscula*), which grows on sites with shallow soils to bedrock or hardpan, would give way to big sagebrush (*Artemisia tridentata*), where the reconstructed surface now consists of topsoil over a reclaimed waste rock dump. (See the previous discussion on soils.)

BLM must consult with the Fish and Wildlife Service when any mining it authorizes might (1) affect a listed species or its designated critical habitat, or (2) is likely to jeopardize proposed species or adversely modify its proposed critical habitat. The effects of mining are weighed against biological and environmental considerations specific to these species. If the net effect is so damaging to the species that the action is likely to jeopardize the species' existence in the wild or adversely modify critical habitat designated for it, the Fish and Wildlife Services renders a "jeopardy" or "adverse modification" opinion. The Fish and Wildlife Service and BLM then seek alternatives or project modifications that relieve such jeopardy or adverse modification.

Alternative 1: No Action

Under the existing regulations, revegetation is expected to continue to evolve toward a greater use of native species with a more equal composition of forbs, shrubs, and trees relative to grasses. The existing regulations would continue to emphasize surface stabilization and erosion control over establishing preexisting plant communities.

Alternative 2: State Management

Except for small disturbances, all the states in the study area have some form of program in place for reclaiming mining disturbance. For activities involving less than 3 to 5 acres of surface disturbance, states like Arizona, Alaska, Montana, Nevada, and Washington do not require operators to notify state authorities of surface-disturbing activities or reclamation. Even though reclamation is required, without oversite, some of these small projects would not receive the same level of revegetation as they might under the existing regulations where notification is required.

State requirements for revegetation are similar to BLM's existing 3809 regulations, but state agencies in general are usually staffed at much lower levels and lack their federal counterpart's resources in administering the mine reclamation program. State agencies are usually located in one central place in contrast to BLM, which has field offices spread throughout the state nearer the mining activities and public lands they manage. BLM offices also have reclamation specialists, soil scientists, wildlife biologists, and range conservationists whose expertise and advice would help to ensure that revegetation consists of a diverse mix adapted to the site. For these reasons, the state's reduced oversite may result in a lower revegetation success under Alternative 2 than under the existing regulations or proposed alternatives.

Under the State Management Alternative weed control would depend on state and local efforts. The lack of a comprehensive policy would likely increase the potential for infestations.

Alternative 3: Proposed Action

Alternative 3 requires that vegetation on reclaimed areas be long lasting, self-sustaining, and comparable in diversity and density to the preexisting natural vegetation. Alternative 3 also stresses the use of native plants in reclaiming mine disturbances. These requirements would impose a more specific and demanding reclamation goal than the existing regulations and result in revegetation closer to the plant communities that existed on the site before mining.

Alternative 3 requires the use of replacement growth media where low-quality topsoil would limit plant growth. Such use would tend to increase the amount of vegetation (biomass) and diversity of plants that could be established and grown on a reclaimed site over that of the existing regulations, which do not specifically address replacement growth media.

The proposed regulations would require that reasonable steps be taken to minimize the introduction of noxious weeds and limit existing infestations. The existing regulations do not specifically address noxious weed control. Therefore, Alternative 3 should lead to better weed control, and controlling noxious weeds is an important measure in promoting the establishment of a productive and desirable postmining plant community.

Under the proposed regulations, all mining and milling projects would require a Plan of Operations, resulting in a more formal review and approval of activities. This added planning should promote better revegetation compared to the existing regulations. In addition, all mining and milling operations would therefore be a federal action and subject to consultation under section 7 of the Endangered Species Act, resulting in a decrease in the likelihood of a taking of an endangered or threatened species.

Under Alternative 3, BLM would have more discretion compared to the existing regulations on the types of impacts operators may cause. The BLM could prohibit operations that would cause substantial irreparable harm to significant resources if this harm could not be mitigated. Given this provision, Alternative 3 would help to maintain population levels of threatened and endangered wildlife species at their current levels.

The Proposed Action would require reclamation bonds for all Notices. This financial assurance should prompt better compliance by the operator than would the existing regulations in reclaiming and revegetating the site. Moreover, should the operator default, BLM would have funds to reclaim the site.

Alternative 4: Maximum Protection

Alternative 4 would require that vegetation on reclaimed areas be long lasting, self-sustaining, and comparable in diversity and density to the preexisting natural vegetation, and achieve 90% of the canopy cover of adjacent, undisturbed lands. Alternative 4 would also require that only native plants be used for revegetation. These requirements would impose a more specific and demanding reclamation goal than the existing regulations and result in revegetation closer to the plant communities that existed on the site before mining.

Alternative 4 would also require that the subsurface soil be salvaged to help restore more of the original soil profile than required by the existing regulations. Restoring more of the soil profile would also promote reestablishing vegetation closer to the plant communities that existed on the site before mining.

Alternative 4 would require that operators prevent the introducing of noxious weeds and eliminate any existing infestations. The existing regulations do not specifically address noxious weed control. Therefore, Alternative 4 should lead to better weed control, which is an important measure in promoting the establishment of a productive and desirable postmining plant community.

Under Alternative 4, Notices would be eliminated and all projects except casual use would require a Plan of Operations. This would result in a more formal review and approval of activities. The added planning should promote better revegetation compared to the existing regulations. In addition, all mining and milling operations would therefore be a federal action and subject to consultation under section 7 of the Endangered Species Act, resulting in a decrease in the likelihood of a taking of an endangered or threatened species.

Alternative 4 would reduce or avoid the injury and mortality of BLM- and state-listed sensitive plant species by requiring that these species be treated as threatened and endangered under the Endangered Species Act.

Alternative 5: NRC Recommendations

Under Alternative 5, all mining projects would require a Plan of Operations, resulting in a more formal review and approval of activities. This requirement should result in better revegetation and a more desirable postmining plant community. In comparison, Notices are acceptable under the existing regulations for projects disturbing less than 5 acres. Notices are not subject to agency approval and may proceed 15 calendar days after submittal. This time frame sometimes leaves inadequate time to identify resources, evaluate impacts, and seek changes from the operator when needed to avoid or minimize impacts.

Compared to the existing regulations, the bonding required by Alternative 5 should prompt better compliance by operators with reclamation measures, including revegetation of sites. Should an operator default, BLM would have funds to reclaim the site. BLM does not have such funds under the existing regulations.

Cumulative and Residual Impacts to Vegetation Resources

An estimated 214,000 acres of public lands were disturbed by exploration and mining in the first 18 years after the 3809 regulations went into effect in 1981. Projections for mineral activities over the next 20 years show that mineral operations under the existing regulations and alternatives would disturb as much as 183,000 more acres. The total surface disturbance on vegetation from past and reasonably foreseeable mineral activities over the final EIS period, therefore, would equal as much as 400,000 acres. This amount represents about 0.12% of the total acreage of public lands and Stock Raising Homestead Act lands administered by BLM within the study area (see Table 3-1). The cumulative impact from mining and exploration on vegetation within the study area is therefore limited.

Residual impacts on vegetation would affect the 400,000 acres disturbed by mineral activities. As discussed in the proceeding section on soil resources, mining changes the original soil profile, which ordinarily requires hundreds to tens of thousands of years to develop. Mining might therefore yield soil substrates that greatly differ from what was there before mining. These differing substrates might affect the rate of succession or completely alter it. Different trajectories of succession are therefore possible, and this altered succession represents a loss of plant communities that existed on the site before mining. Alternative 4 would require more of the soil profile to be salvaged than would the other alternatives, resulting in a better chance of establishing similar substrates able to support vegetation that existed on a site before mining.

RIPARIAN-WETLAND RESOURCES

Affected Environment

BLM manages 181,000 miles of stream and lake shore riparian habitat and 13 million acres of wetlands consisting of swamps, bogs, marshes, muskegs, and wet meadows (Table 3-23). Even though this ecotype represents only 5% of the land BLM manages, it consists of some of the most productive habitat on BLM-managed land. These valuable riparian-wetlands are not protected under one comprehensive national wetland law. Rather, federal statutes regulating or otherwise protecting wetlands have evolved piecemeal over the years and often use laws intended for other purposes (GAO 1991b).

Definitions used by agencies to determine regulatory jurisdiction over riparian-wetland areas are as variable as the classifications of riparian-wetland areas themselves (Cowardin and others 1979). The U.S. Army Corps of Engineers and BLM use the two definitions described below for managing wetlands on BLM-administered lands.

Congress enacted the Clean Water Act in 1972 to maintain and restore the chemical, physical, and biological integrity of the waters of the United States. Section 404 of the Clean Water Act authorizes the Secretary of the Army to issue permits for the discharge of dredged or fill material into the waters of the United States, including wetlands. During 1987 the Army Corps of Engineers established the guidelines and methods for determining whether an area is a wetland (jurisdictional) for the purposes of permitting and enforcing Section 404. The Army Corps of Engineers and the Environmental Protection Agency (EPA) defined “wetland” as follows:

> *Those areas that are inundated or saturated by surface or ground water (hydrology) at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation (hydrophytes) typically adapted for life in saturated soil conditions (hydric soils). Wetlands generally include swamps, marshes, bogs, and similar areas (40 CFR 232.2(r), Environmental Laboratory 1987).*

Jurisdictional wetlands–those regulated by the Army Corps of Engineers under Section 404 of the Clean Water Act–must exhibit all three characteristics: hydrophytes, hydric soils, and hydrology. The prevalent vegetation must consist of hydrophytic species, meaning species that can grow, effectively compete, reproduce, and/or persist in anaerobic soil conditions. Hydric soils must be present, or the soils must have characteristics of reducing soil conditions. Last, the area must be inundated either permanently or periodically at mean water depths not exceeding 6.6 feet, or the soil must be saturated to the surface at some time during the growing season of the prevalent vegetation (Environmental Laboratory 1987).

During 1991 BLM developed its *Riparian-Wetland Initiative for the 1990's* (BLM 1991b) to provide a strategy for managing and restoring riparian-wetland areas on BLM lands. BLM

Table 3-23. Condition of BLM-Managed Riparian-Wetland Areas by State										
State	Habitat Type	Proper Functioning Condition	%	Functional at Risk	%	Non Functional	%	Unknown	%	Total
AK	Riparian (mi)	132,023	91	35	<1	812	1	11,434	8	144,304
	Wetland (ac)	12,376,200	98	unknown		unknown		188,800	2	12,565,000
AZ	Riparian (mi)	308	34	410	46	22	2	153	17	893
	Wetland (ac)	85	<1	17,949	82	3,027	14	838	4	21,899
CA	Riparian (mi)	1,865	52	1,199	33	101	3	425	12	3,590
	Wetland (ac)	11,273	85	10,571	12	413	<1	237	3	22,494
CO	Riparian (mi)	2,119	47	1,535	34	762	17	53	1	4,469
	Wetland (ac)	4,986	67	707	9	3	<1	1,780	24	7,476
ES*	Riparian (mi)	0	0	0	0	0	0	10	100	10
	Wetland (ac)	0	0	0	0	0	0	4,300	100	4,300
ID	Riparian (mi)	1,377	37	1,462	39	379	10	536	14	3,754
	Wetland (ac)	1,361	10	1,324	10	248	2	10,200	78	13,133
MT	Riparian (mi)	2,048	42	2,225	46	523	11	57	1	4,853
	Wetland (ac)	4,444	7	693	1	859	1	56,518	91	62,514
NV	Riparian (mi)	660	27	1,127	46	392	16	268	11	2,447
	Wetland (ac)	8,821	26	1,712	5	4,098	12	19,566	57	34,197
NM	Riparian (mi)	160	35	218	48	72	16	4	1	454
	Wetland (ac)	1,663	30	10	<1	776	14	3,114	56	5,563
OR	Riparian (mi)	2,678	40	3,240	48	270	4	557	8	6,745
	Wetland (ac)	126,808	86	3,521	2	478	1	15,896	11	146,703
UT	Riparian (mi)	1,798	38	1,483	31	388	8	1,053	22	4,722
	Wetland (ac)	5,047	36	3,456	24	470	3	5,207	36	14,180
WY	Riparian (mi)	1,528	32	2,476	51	649	13	177	4	4,830
	Wetland (ac)	4,236	21	5,463	27	345	2	10,235	50	20,279
Total Lower 48	Riparian (mi)	14,541	40	15,375	42	3,558	10	3,293	9	36,767
	Wetland (ac)	168,724	48	45,406	13	10,717	3	127,891	36	352,738

Tota l BL M	Riparian (mi)	146,564	81	15,410	9	4,370	2	14,727	11	181,071
	Wetland (ac)	12,544,924	97	45,406	<1	10,717	<1	316,691	3	12,917,738
*Eastern States. Source: *Public Land Statistics 1999* (BLM 2000a)										

Manual 1737, Riparian-Wetland Area Management, defines riparian-wetland areas as follows:

> *A form of wetland transition between permanently saturated wetlands and upland areas. These areas exhibit vegetation or physical characteristics reflective of permanent surface or subsurface water influence. Lands along, adjacent to, or contiguous with perennially and intermittently flowing rivers and streams, glacial potholes, and the shores of lakes and reservoirs with stable water levels are typical riparian areas. Excluded are such sites as ephemeral streams or washes that do not exhibit the presence of vegetation dependent upon free water in the soil.*

The Army Corps of Engineers does not regulate all areas that BLM considers riparian-wetland. The Corps' regulatory jurisdiction applies only to wetlands that have *all three* attributes: hydrophytes, hydric soils, and hydrology. BLM recognizes areas exhibiting any one of these attributes (hydrophytic vegetation) as riparian-wetland areas.

Proper Functioning Condition

One of the chief goals of BLM's Riparian-Wetland Initiative is to restore and maintain riparian-wetland areas in proper functioning condition. Proper functioning condition for riparian-wetland areas is defined in BLM Technical Reference 1737-9 (BLM 1995a):

> *Riparian-Wetland areas are functioning in proper condition when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality; filter sediments, capture bedload, and aid floodplain development; improve flood-water retention and ground water recharge; develop root masses that stabilize stream banks against cutting action; and develop diverse ponding and channel characteristics are created to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity. The functioning condition of riparian-wetland areas is a result of interaction among geology, soil, water, and vegetation.*

Riparian-wetland areas that are not functioning properly are rated as functional at risk or nonfunctional. Functional at risk areas are in functional condition, but an existing soil, water, or vegetation condition makes them susceptible to degradation. Nonfunctional areas are clearly not providing adequate vegetation, landform, or large woody debris to dissipate the stream energy of high flows and thus are not reducing erosion, improving water quality, and performing the other functions listed above. The absence of certain physical attributes, such as, a lack of floodplain, are indicators of nonfunctioning condition. Table 3-23 shows the functional status of riparian-wetlands by state.

Riparian-Wetland Functions

The capability and potential of any riparian-wetland area is dictated by the interactions of water, soils/landforms, and vegetation. These interactions depend largely on the climatic extent and frequency of flooding and drought. Water that infiltrates into floodplains of lotic (streams, springs) systems during periods of high flow returns to the channel during periods of low flow, contributing a cool source of summer base flow for many streams, especially in low-elevation alluvial valleys. Seasonal inundation of the floodplain also reduces water velocities during flooding and helps reduce downstream flood peaks. Both of these factors reduce the risk of channel erosion. Lentic riparian-wetland areas (bogs, marshes, swamps) also perform many of the same functions:

- Detaining storm runoff.
- Reducing flow peaks and erosion potential.
- Retaining and filtering sediment.
- Augmenting ground water recharge by storing water and releasing it more slowly, later into the dry season.

Riparian-wetland vegetation plays a critical role in many physical processes within all riparian-wetland areas. This vegetation promotes streambank stability and contributes organic matter and large woody material to riparian-wetland areas. Densely vegetated riparian-wetland areas buffer the input of sediment and toxic chemicals from runoff generated on adjacent lands. Riparian-wetland vegetation also aids in aquifer recharge and in floodplain development by trapping sediment (Gregory and others 1991; Henjum and others 1994; Hicks and others 1991; Kovalchik and Elmore 1992; Sedell and others 1990).

The Role of Riparian-Wetlands Areas as Habitat

Riparian-wetland areas contain the most biologically diverse habitats on BLM-managed lands because of their closeness to water bodies and because they provide a variety of structural features, including live and dead vegetation. These areas are valuable to wildlife for food, cover, and water, and provide the following:

- Important habitat for about 80% of our wildlife species.
- Nesting and brooding habitat for birds.
- Thermal cover and favorable microclimates because of their shade, increased humidity and air movement, and higher rate of transpiration.

Common deciduous trees and shrubs such as cottonwood, alder, and willow are important food sources for deer, elk, moose, hares, rabbits, voles, and other animals.

Riparian-wetlands also perform the following functions:

- Serve as big game migration routes between summer and winter ranges.
- Provide travel corridors between habitat types for many species, including carnivores, birds, bats, and small mammals.
- Play an essential role within landscapes as corridors for the dispersal of plants.

More bird species use these areas than any other habitat type. Many neotropical migratory birds use these areas exclusively or in combination with only one other habitat type. In the Interior Columbia River Basin, 64% of neotropical migratory land birds depend on riparian-wetland vegetation during the breeding season. This habitat may harbor from 2 to10 times as many birds as does adjacent, nonriparian-wetland vegetation (Partners in Flight 1998).

Riparian-wetland vegetation directly influences the condition, quality, and maintenance of aquatic habitat. The complexity, hydraulic resistance, and stability given by riparian vegetation to streams often affect the size, shape, and distribution of channel features such as pools, riffles, and undercut banks (Sedell and Beschta 1991). Streamside vegetation moderates water temperatures throughout the year by creating shade in the summer and providing insulation in the winter. The sediment and chemical filtering function of riparian-wetland vegetation helps maintain high water quality required by many aquatic organisms.

Riparian-wetland vegetation also alters the relatively simple chemistry of nutrient production and transport into a complex array of storage locations, transformations, and nutrient spirals (Gregory and others 1987; Pinay and others 1990). In addition, riparian-wetland vegetation helps to maintain the hydrologic connectivity between main-stem stream channels and smaller side channels and hyporheic zones (Stanford and Ward 1988; Gilbert and others 1990).

Status of Riparian-Wetland Areas

Over the past 100 to150 years, riparian areas and wetlands have been subject to increasingly concentrated and competing resource demands, including the following:

- Water withdrawal.
- Mineral, sand, and gravel extraction.
- Human settlement.
- Farming and timber harvesting.
- Livestock and wildlife use.
- Recreation.

Many riparian-wetlands have been drained, filled, or sprayed with herbicides and pesticides.

Additionally, riparian-wetland areas have been affected by the invasion of nonnative plants and introduced aquatic and terrestrial species (bullfrogs, nutria). On many sites these nonnative species have become well established, commonly replacing native species or exerting large influences on native habitats. As a result, many riparian areas and wetlands are greatly altered from conditions noted by explorers in the early 1800s. Riparian-wetland systems are responsive and dynamic. When modified, they can significantly affect adjacent aquatic and terrestrial ecosystems.

Broad-scaled trends generally show that riparian-wetland areas have been reduced in abundance and that habitat fragmentation has significantly increased. In some regions of the country 95% of the riparian-wetlands historically present are gone. According to BLM (1998c), 58% of all flowing-water areas that have been assessed are either nonfunctional or functional at risk, whereas 26% of all standing-water areas were assessed as nonfunctional or functional at risk. BLM reported that from 1981 to 1997 a total of 20,127 acres of riparian-wetland habitat were lost or degraded by placer mining alone.

Other types of mining also affect riparian-wetland areas but to a lesser degree. For example, riparian-wetland disturbance estimates in the Zortman-Landusky Mine EIS suggest that from 1% to 2% of the total land affected by open pit mining may be riparian areas or wetlands (BLM and Montana Dept. of Environmental Quality 1996). Some of the mining since 1981, particularly placer mining, has taken place on lands previously or historically mined. Previously disturbed riparian-wetland areas are in various states of recovery. Most of these areas would be classified as nonfunctional or functional at risk.

Effects of Mining on Riparian-Wetland Systems

Natural riparian-wetlands systems have evolved over tens, hundreds, and thousands of years. It may take 2 to 3 years for herbaceous riparian-wetlands to become structurally established. Fifteen years may be needed for a carefully managed forested riparian-wetland area to achieve canopy closure and to begin to look and function like a natural forested system. And decades to centuries may pass before the area approximates the structure and function for the habitat it was intended to duplicate (North Carolina State University 1998; BLM and Montana Dept. of Environmental Quality 1996; BLM 1988a).

Loss of Vegetation and Vegetative Function. Mineral activities, placer operations in particular, lead to a loss of riparian-wetland vegetation. Operations remove all vegetation within the active mining area before and during mine development and operation. Vegetation next to the mining area may be affected by roads, water diversions, or other development.

Riparian-wetland vegetation significantly influences the stability of uplands and certain stream types. Changes in the composition, vigor, and density of riparian vegetation can result in changes in the following:

- Sediment input from uplands.
- Stream shade.
- Protection from instream erosional processes.
- Terrestrial insect habitat.
- Contribution of detritus and structural components to the stream channel.

Disturbance to riparian-wetlands also affects water quality and esthetic values (Rosgen 1996).

Nonnative Species. One of the most pervasive and ecologically damaging effects of human activities is widespread movement of species beyond their natural range. In North America, hundreds of exotic (or nonnative) plants have become established in aquatic habitats during this century (Ricciardi and Rasmussen 1998). Typically, only a small proportion of introduced species cause significant impacts. But some of these species have had enormous ecological impacts (Schmitz and Simberloff 1997). Nationwide, nonnative species have been implicated in the decline of 42% of species listed under the Endangered Species Act.

The ability of nonnative species to spread rapidly and out compete native plants is of concern because weeds can render land unfit or greatly limit beneficial uses of the land. Human disturbance of wetland systems by activities such as mining creates conditions that may encourage the spread of invasive species. Wetland creation or restoration projects that include nonnative species can contribute to the problem by promoting their spread faster than through natural dispersal. Although wetlands that are reclaimed with or invaded by nonnative vegetation appear to be healthy, they have little or no value for biodiversity (Flack and Benton 1998).

Furthermore, some introduced species can alter riparian-wetland ecosystems processes and functions. Others may change the structure and composition of natural communities. Many riparian-wetland invaders alter the hydrologic dynamics, fire regimes, nutrient cycling, soil chemistry, or sedimentation rates in systems where they occur (Flack and Benton 1998).

Some species such as tamarisk (saltcedar) can seriously alter hydrological regimes. Tamarisk is a deep-rooted plant that transpires water at a much higher rate than native riparian-wetland species. As a result, tamarisk can greatly lower the water table. Tamarisk also promotes flooding by blocking water channels.

Spotted knapweed and yellow star thistle are two of many weeds that can infest a variety of habitat types, including hydric sites. Both of these weeds are highly competitive and easily invade disturbed lands or deteriorated sites. These deep-rooted weeds and can out compete native species with shallow roots, thereby creating weed monocultures. Spotted knapweed can inhibit the growth of surrounding vegetation by exuding toxins through its roots and leaves. As these weeds out compete the native species, the amount of bare ground increases. Increased bare ground can lead to problems with streambank stability and increased sedimentation, especially during peak flows (Williams 1997b; Elmore and Leonard 1998). Healthy riparian-wetland systems may out compete nonnative weed invasions and also inhibit the dissemination of weed seeds through filtering capabilities.

Erosion, Sedimentation, and Altered Stream Channel Morphology. Mining accelerates sediment production. Because of the large area of land disturbed by mining and the large amounts of earthen materials exposed at sites, erosion can be a major concern at mining sites. Erosion may cause significant loadings of sediments to nearby water bodies and riparian-wetland areas, especially during severe storms and high snow melt periods. Placer mining degrades or destroys channel features, increasing erosion and sedimentation. Fine sediment from erosion can clog wetland vegetation and impair the wetland's water-holding capacity. Excessive sediment loading can cause channel aggradation and further accelerate bank instability (Elmore and Leonard 1998).

In streams with hard bottoms, accelerated runoff can result in destructive lateral erosion of streambanks and progressively wider and shallower stream channels. In streams with soft bottoms, accelerated runoff can trigger downcutting, which has the following effects:

- Lowers the streambed and water table.
- Dries out riparian areas.
- Destabilizes streambanks.
- Increases erosion.
- Further accelerates runoff.

Unless stopped by some form of intervention or a hard geologic formation, downcutting will migrate upstream and eventually disrupt the hydrologic functioning of the entire watershed (Chaney and others 1993).

Surface erosion, which occurs in denuded areas, is a major contributor to sedimentation in rivers. An example of how surface erosion can introduce sediment into rivers was demonstrated by a New Mexico study that found the following:

- Surface erosion produced 13,600 tons per square mile per year.
- Gully erosion contributed 200 tons.
- Mass movement involved 90 tons (Leopold 1994).

Stream channels become unstable when excessive sediment deposition leads to destructive lateral erosion of streambank and progressively wider and shallower stream channels.

Stream channels are commonly relocated into bypass channels during placer operations. Alterations of channel morphology result in three possible outcomes:

- Moving the main water flow from a natural channel to an upland soil and associated vegetation can result in either vertical or lateral instability depending on the soil type and underlying geology.
- Stream channel relocation often results in the straightening or decreasing of the total channel length. This decrease in length increases the gradient and energy, resulting in incision. Downcutting from such an incision can progress far above the disturbed area with the resulting sediments affecting stream morphology far downstream.
- Sediment overloading from direct inputs such as waste rock, overburden, and tailings piles; dams; roads; and newly reclaimed areas can cause channel aggradation from increased bedload. Channel aggradation increases stream energy on banks and can start lateral instability and further sedimentation. In addition, increased velocities and volume of runoff can lead to downstream flooding, scouring of stream channels, and a loss of streamside riparian vegetation (Elmore and Leonard 1998).

Pollution. Mining can release pollutants to surface and ground water, result in the depositing of contaminants into soils, and eventually lead to incorporating pollutants into plant tissue. Both water and soil contamination may harm riparian-wetland vegetation. Studies have shown a general relationship between concentrations of metals in soils and in plants (Mullen 1994; Lipton and others 1993).

Total metal accumulation by plants from soil depends on many factors, including

- The nature of the plants, species, growth rate, root size and depth, transpiration rate, and nutritional requirements.
- Soil factors such as pH, organic matter content and nature, nutrient status, amount of metal sulfides, and clay content and type.
- Environmental and management variables such as temperature, moisture, sunlight, and amendments and fertilization.
- Modes of metal toxicity and plant tolerance (Overcash and Pal 1979).

General effects of metal accumulation in plants include stunted growth of roots and tops, browning of leaves, interveinal chlorosis, wilting of the leaves, and red or brown spots on the leaves. But each case of plant phytotoxicity is different, and many plants may show no visible signs of injury (BLM and Montana Dept. of Environmental Quality 1996).

Naturally occurring substances in the ore may create a major source of pollutants. Mined ore contains not only the mineral being extracted but varying concentrations of a wide range of other minerals. Often other minerals may be present at much higher concentrations and can be much more mobile than the target mineral. Depending on the local geology, the ore and the surrounding waste rock and overburden can include trace levels of aluminum, arsenic, asbestos, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, selenium, and zinc, as well as naturally occurring radioactive materials.

Ground Water Drawdown. Ground water drawdown and associated impacts to surface waters and nearby wetlands can be a serious concern in some areas, particularly in the Carlin Trend of northeast Nevada. Several Carlin Trend gold mines are dewatering open pits. Over the last decade, these large mines have placed new and increased demands on water resources within the Humboldt River Basin. Currently, 14 large-scale and many smaller open pit gold mines are active in the basin. Large volumes of ground water are being pumped for pit dewatering, milling, and other activities.

The Nevada Engineer's Office established four acceptable methods of disposing of ground water: reinjection, storage in infiltration reservoirs, irrigation for agriculture, and discharge into surface channels. As of 1998, about 65% of the water pumped for dewatering was being discharged into tributaries of the Humboldt River, almost doubling the average annual flow of the river. This increased flow has altered natural channel morphology and flow characteristics, created temporary wetlands, and caused local flooding.

But some benefits are being realized from the discharge of the pumped water in natural water courses, including increases in water for agricultural irrigation and developing of sport fisheries in storage reservoirs. As gold mining operations cease (estimated at 15-20 years), water flows in the Humboldt River basin will be reduced to a level below premining levels. The abandoned open mine pits will fill up with water from the surrounding water tables. Water supplies in the basin are predicted to be insufficient for user demands, wildlife and fisheries needs, and maintenance of riparian/wetland areas such as the terminal wetlands in the Humboldt Wildlife Management Area. The impacts of ground water drawdown could last for many decades.

Mitigation. The most common mitigation applied to mine-related loss or disturbance is to create replacement riparian-wetland areas. Small- and large-scale mitigation can be successful and have positive ecological benefits for an area. When properly designed and maintained, the new riparian-wetland areas will eventually emulate natural systems. Although mitigation ideally provides a mechanism for both development and the protection of riparian-wetland functions, the uncertainty of creating riparian-wetlands has been a subject of concern (Reutter and Brinckerhoff 1998).

Regulatory and Enforcement Concerns. Street (1998), Reutter and Brinckerhoff (1998), and Sibbing (1997) discussed a number of problems in the mitigation process. First, few permitted riparian-wetland mitigation projects follow scientific designs. Instead, projects are often negotiated between the applicant and the regulatory agency with less site assessment or mitigation design than might be needed to guarantee success. Second, many mitigation projects fail for a lack of sustained hydrology. Poor planning and unexpected results of construction often lead to a change in ground or surface water supply to small, marginal-quality riparian-wetland areas.

Permittees may often not build wetlands, may not build a large enough area, or may build riparian-wetland areas that otherwise do not comply with the design specified in their permit. Permitting agencies sometimes allow the substitution of unlike types of riparian-wetlands in mitigation or require less-than-equal amounts of mitigation. Constructed riparian-wetland areas often do not function as expected. Finally, agency compliance monitoring is often inconsistent or cursory for key components and does not consist of detailed studies to evaluate wetland function.

Functional Replacement Concerns. A significant problem noted in mitigation compliance surveys is that, although complex wetlands may be affected, mitigation programs often create different, simpler riparian-wetland types. For example, some agencies lean toward building deeper and open water systems. This type of out-of-kind creation or restoration ignores the unique values of drier end areas, including their role in flood water storage, habitat for reptiles and amphibians, food sources for migratory waterfowl and shorebirds, and water quality improvement. Also ignored is that many nonregulatory wetland incentive programs target restoration of these same kinds of emergent wetlands, slighting drier end wetlands (Sibbing 1997). But out-of-kind mitigation can be beneficial if the wetland is dysfunctional to begin with.

Wetland functions may take many years to develop. Wooded wetlands, in particular, take a long time to become established because trees and shrubs need time to grow. Street (1998) found that a 5-year monitoring program was inadequate for assessing the effectiveness of a mitigation prescription in a wooded area. The mitigation sites examined in the study had begun to exhibit some wetland functions, but many years would be needed to see the ultimate functions provided by the sites.

The methodologies used in building mitigation sites might result in failure. Typically, construction of riparian-wetland areas includes excavating large amounts of soils to reach the level of seasonal-high ground water table. Construction commonly strips off the developed soil profile and topsoil and exposes the underlying subsoil of parent material. Although the organic matter is added to or stockpiled, little organic material remains for later incorporation. With little soil organic matter, it becomes more difficult for wetlands to remove nutrients from the ground and surface water. As a result, soils less likely to support vegetation that will filter nutrients, sediments, and pollutants. Additionally, the ability of mitigation projects to compensate for lost functions would be limited by the hydrogeomorphic characteristics of a site (Street 1998).

Location-Dependent Functions. Many of the functions and values of a particular riparian-wetland area are site specific. For this reason an agreement between the Army Corps of Engineers and EPA in 1990 determined that on-site mitigation would be used when possible. If on-site mitigation is not possible, mitigation should occur nearby and within the same watershed. Only in the absence of other options should mitigation occur outside the watershed of the affected wetland. Functions tied to landscape position include aspects of water storage and attenuation, species habitat, and nutrient cycling.

Temporal Replacement of Functions. The standard practice of constructing mitigation areas concurrently with conducting permitted wetland impacts results in temporal loss of wetland functions while the newly created areas become established, a process that can take years, even under favorable conditions. Projects may pay little regard to short-term riparian-wetland function. Many regulatory programs do not even try to offset this temporal loss of function (Reutter and Brinckerhoff 1998).

Environmental Consequences

Impacts Common to All Alternatives

The nature of impacts, as discussed above, would be similar for all alternatives where disturbance is unavoidable in accessing and extracting minerals from an ore body. In summary, loss and degradation of riparian-wetland areas might result from the following:

- Direct removal (stripping) of vegetation and loss of vegetative function.
- Increased erosion and sedimentation.
- Water and soil contamination.
- Ground water drawdown.

The level of mitigation required by each of the alternatives would help offset disturbance as discussed below.

Under all five alternatives impacts to jurisdictional wetlands would be mitigated according to Section 404 of the Clean Water Act and administered by the Army Corps of Engineers with oversight from EPA. State mitigation might also help offset wetland loss in states requiring wetland mitigation.

Alternative 1: No Action

Alternative 1 has no requirement to avoid disturbance or mitigate impacts to nonjurisdictional riparian-wetland habitat. But BLM generally mitigates impacts to riparian-wetland areas as a part of fish and wildlife rehabilitation or with water quality improvements. One of the goals of BLM's riparian-wetland policy is to restore or maintain riparian-wetland areas in proper functioning condition. But mitigation would not necessarily do the following:

- Be conducted on an acre-disturbed-per-acre-restored basis.
- Provide for scientifically designed restoration based on site-specific riparian-wetland assessments.
- Replace lost riparian-wetland function with a similarly functioning system in a timely manner.

Many years or decades would be needed for newly created riparian-wetlands to function like the natural systems they are designed to replace.

In addition, project mitigation usually would not consider the spacial distribution of natural riparian-wetland systems. Because water quality and fish and wildlife habitat parameters are more strongly correlated to riparian-wetland position than riparian-wetland extent (Pastor and Johnston 1992), the goal of attaining proper functioning condition may not be met.

Alternative 2: State Management

Because mitigation would be required only for jurisdictional wetlands (and not riparian-wetlands meet BLM's but not the Army Corps of Engineers definition), riparian-wetlands would not be restored on a large portion of the disturbed riparian-wetland habitat. For example, Newmont Gold's South Operations project could disturb 1,342 acres of riparian-wetland (streambank) habitat, of which 64% is within the jurisdiction of the Army Corps of Engineers (EPA 1997).

If jurisdictional wetlands make up 64% of the total affected riparian-wetland area, Alternative 2 could cause a long-term loss of 36% more riparian-wetland areas than would Alternative 1, except in states having standards addressing the postmining condition of fish and wildlife habitat. In these states, riparian-wetlands might indirectly benefit as a result of mitigation or rehabilitation required for fish and wildlife. For example, California recommends that wildlife habitat be restored to its premining condition (McElfish and others 1996).

Alternative 3: Proposed Action

Disturbance to riparian-wetland habitat would likely be reduced in areas away from the ore body. Such areas would undergo less disturbance from construction of access, waste rock placement, tailings impoundments, and leaching facilities. Riparian-wetlands within the area of the ore body would likely be lost or degraded. Where disturbance is unavoidable, operators would be required to apply riparian-wetland mitigation. The weakness in the mitigation process would be that similarly functioning riparian-wetland areas would probably not be replaced in a timely manner or by similarly located riparian-wetlands. Many years or decades would be needed for newly created riparian-wetlands to function like the natural systems they are designed to replace.

Under the Proposed Action all mining would require a Plan of Operations. BLM's ability to require baseline environmental information for Plan-level operations, such as detailed studies of riparian-wetland function, should help increase the success rate of riparian-wetland mitigation through improved design. Exploration disturbing less than 5 acres would be allowed under a Notice, but the bonding of Notice-level operations and the requirement to meet the performance standards to prevent unnecessary or undue degradation should greatly reduce disturbance or reduce long periods of nonfunctioning riparian-wetlands resulting from Notice-level operations in the past.

Bonding requirements under the Proposed Action would not address unplanned events such as spills or facility failures or unforeseen changes to water supply or quality. Therefore, riparian-wetland resources might be exposed to these impacts without monetary support for corrective action. In areas having unusually high-value riparian-wetlands, or riparian-wetlands that support other species of significant value (e.g. endangered species), BLM might deny mining if operators could not suitably mitigate adverse impacts.

Alternative 4: Maximum Protection

Under Alternative 4 impacts to riparian-wetland resources would generally be similar to those under the other alternatives. But the duration and extent of the impacts could be greatly reduced by the restoration time requirement. As under Alternative 3, Alternative 4 would reduce disturbance to riparian-wetland habitat away from the immediate vicinity of the ore body. Riparian-wetlands within the area of the ore body would likely be lost or degraded.

Where disturbance is unavoidable, riparian-wetlands would be restored or replaced to a proper functioning condition within 10 years of the completion of mining and at a rate of 1.5 acres restored per 1 acre disturbed. The less-than-certain nature of mitigation would be somewhat offset by the following:

- The time requirement for restoration.
- The proper functioning condition standard.
- The greater restoration-to-disturbance ratio
- BLM's ability to require baseline environmental information, such as detailed studies of riparian-wetland function.

Bonding under this alternative would cover unplanned events. As a result, financial guarantees would help correct situations in which unforseen events harm riparian-wetland resources.

As under Alternative 3, Alternative 4 incorporates the substantial irreparable harm standard into the definition of unnecessary or undue degradation. In addition, Alternative 4 would require that riparian-wetland areas be restored to proper functioning condition within 10 years after mining ceases. In combination, these two elements of Alternative 4 would much better protect riparian-wetland areas than would the other alternatives. Under Alternative 4 BLM could deny mining in riparian-wetland areas when mitigation is not predicted to meet the 10-year restoration requirement.

Alternative 5: NRC Recommendations

Under Alternative 5, mining would require a Plan of Operations, and exploration disturbing less than 5 acres would require a Notice as under Alternative 3. Notice-level bonding under Alternative 5 would help ensure that performance standards are met, but bonding would not cover unplanned events that degrade riparian-wetland habitat. The definition of unnecessary or undue degradation under Alternative 5 would not include the substantial irreparable harm standard. Thus BLM could not deny mining in areas of high-value riparian-wetland habitat when disturbance could not be mitigated.

Alternative 5 would slightly better protect riparian resources than would Alternative 1 because of the new riparian performance standard. But Alternative 5's riparian performance standard would not include wetlands and would protect only the wetlands that meet the Army Corps of Engineers' jurisdictional standard. In addition, Alternative 5 would not require restoring riparian-wetlands to proper functioning condition.

AQUATIC RESOURCES

Affected Environment

The aquatic community consists of three main components:

- Aquatic plants (phytoplankton, periphyton, and rooted vascular macrophytes), which fix energy from sunlight.
- Bacteria and fungi, which decompose organic matter.
- Consumers, including invertebrates and fish, which use energy from plants, bacteria, and fungi.

The habitat requirements for fish include a healthy, functioning aquatic ecosystem consisting of all three community components, as well as the proper physical and chemical attributes.

Aquatic Habitat and the Fish It Supports

BLM manages 132,190 miles of fish-bearing stream habitat, which includes 17,281 miles of habitat used by anadromous species. In addition, BLM manages more than 2.9 million surface acres of lake and reservoir habitat (Table 3-24).

Table 3-24. BLM-Managed Fisheries Habitat by State			
State	Total Fish-Bearing Stream Miles	Anadromous Stream Miles	Lake and Reservoir Surface Acres
Alaska	115,000	15,145	2,600,000
Arizona	700	0	14,200
California	850	220	163,000
Colorado	1,900	0	17,600
Eastern States	20	0	3,620
Idaho	2,820	314	750
Montana	720	0	6,670
New Mexico	260	0	120
Nevada	1,400	0	33,190
Oregon/Washington	3,200	1,602	32,770
Utah	3,390	0	15,230
Wyoming	1,930	0	6,430
Totals	132,190	17,281	2,893,580
Source: BLM 1993, 1996a.			

This habitat ranges from high mountain lakes to reservoirs and from large rivers to small first-order tributaries. These aquatic systems occur in a wide variety of climatic and regional settings, ranging from the arid regions of Arizona, New Mexico, and southern California, to the more temperate streams of the Pacific Northwest and the arctic systems of Alaska.

Of the total aquatic habitat under BLM administration, 7% (9,170 miles) of the stream and 0.3% (8,210 acres) of the lake habitat are under or proposed for special status. The breakdown of the special status areas is shown in Table 3-25.

Table 3-25. BLM Aquatic Habitat under or Proposed for Special Status		
Status	**Stream Miles**	**Surface Acres of Lakes**
Areas of Critical Environmental Concern (ACECs)	3,200	1,500
Wilderness Areas	90	NA
National Conservation Areas	1,600	250

Wild and Scenic Rivers	1,100	NA
Wilderness Study Areas (43 CFR 3802)	1,200	5,600
Proposed for Special Designation	1,980	860
Total	9,170	8,210
Source: BLM 1993		

To date, only about 3% of the stream habitat and 1% of the lake habitat under BLM management has been intensively inventoried for habitat condition, quantity, and trend, or had management objectives developed through habitat management plans, (BLM 1993; 1996a). Of the 1,700 miles of nonanadromous stream and 39,500 acres of lake habitat for which objectives have been developed, about half of the habitat meets the objectives (BLM 1993). About 33% (1,220 miles) of the anadromous stream habitat managed by BLM in California, Oregon, Washington, and Idaho is in optimal condition. The remainder is in fair to minimal condition. In Alaska 98% (14,800 miles) of the anadromous stream habitat under BLM management is considered to be in natural or near-natural condition, and 2% (319 miles) is in fair to minimal condition (BLM 1996a).

BLM defines optimal, fair, and minimal aquatic habitat conditions as follows:

Optimal aquatic habitat condition: *watershed not greatly impacted. Riparian areas in near natural condition; abundant, diverse instream structure. Numerous deep, complex pools with cover. Substrate (gravels) relatively free of fine sediment. Stable streambanks and stream channels. Water quality and quantity are generally unaltered from natural conditions.*

Fair aquatic habitat condition: *watershed minimally impacted by activities in the past; natural riparian vegetation altered or removed in past; limited amounts of large woody debris; fine sediments above natural levels; some adverse changes in water quality and quantity; habitat partly recovered or still in a decreasing trend.*

Minimal aquatic habitat condition: *major alterations in the watershed, water quality, water quantity, or natural stream habitat and riparian areas; few or no large trees or mature native vegetation in riparian areas; little or no large woody debris; pools few and shallow; and excessive sedimentation of the streambed.*

From 4% to 8% of the 790 species of native freshwater fish in the United States inhabit each of the western states within the study area (Page and Burr 1991). About 90% of these fish are nongame species, and many have a limited distribution and are found nowhere else in the world. The species inhabiting BLM public lands are best represented by members of the following families: Salmonidae (nonanadromous and anadromous salmonids); Cottidae (sculpin); Catostomidae (suckers); Esocidae (pike); Percidae (darters and other perches); Centrarchidae (sunfishes); Cyprinidae (minnows); Cyprinodontidae (killifishes); Ictaluridae (bullhead catfishes); Petromyzontidae (lampreys); Gadidae (burbot); and Gasterosteidae (sticklebacks).

Much is known about the life history and habitat requirements of some of these species, and nothing is known about others. All of the species are important to the natural functioning of their ecosystems, and many species have social or economic value.

Habitat Factors That Influence Fish Abundance

Habitat needs for fish vary with the species, season of the year, and life stage. A variety of chemical, physical, and biological parameters interact to provide the range of environmental conditions that allow the species to exist. Some of the more important parameters include water quality, streamflow, cover, substrate, and energy (food) availability. These parameters are directly influenced by riparian function. But the following all play a role in defining the condition: climate, geology, soils, topography, upland vegetation, hydrology, land use within a watershed, and quality of the aquatic environment.

Fish respond to these parameters both physiologically (altered growth rates and health) and behaviorally (site selection and community interaction). Fish generally respond to these environmental factors in combination. Where fish can live and reproduce, the range of environmental conditions must be suitable throughout their lives. To show the complexity and often narrow range of environmental conditions required by fish, the following narrative [from Bjornn and Reiser (1991) unless otherwise cited] discusses the habitat requirements of salmonids (e.g. trout, salmon, and char), a group that represents many species in streams near land open to mining.

Water Quality. Salmonids require water with the following characteristics:

- High concentration of dissolved oxygen (>75% saturation).
- Nearly neutral to slightly alkaline (pH 6.5-8.7).
- Free from toxic concentrations of heavy metals and other chemicals.
- Sediment levels (bedload and suspended) that approximate natural undisturbed conditions.

In addition, water temperature plays a crucial role in defining suitable water quality for fish.

The timing of salmonid spawning has evolved in response to water temperatures in each stream before, during, and after spawning. Water temperatures can influence the upstream migration of adult spawners and delay the entry of spawners into their natal streams.

Temperature also determines the rate of embryo and alevin (newly hatched fish still attached to the egg yolk) development. Within the temperature threshold for successful spawning and incubation, 4-14 C (Bell 1986), warmer temperatures result in shorter development times. In many streams winter temperatures fall below the 4 C minimum recommended for incubation, but the eggs develop normally because the spawning and development occurred when temperatures were within the suitable range.

Water temperature also determines the capacity of water to hold oxygen in solution. The relationship is an inverse one, with oxygen solubility lower in warmer water. Salmonids can survive relatively low concentrations of dissolved oxygen for short periods. But low concentrations adversely affect growth rate, swimming performance, and the efficiency of food conversion.

Streamflow and Water Velocity. Adequate streamflow is important for providing fish passage (both for upstream migrating adults and downstream migrating juveniles). Streamflow also regulates the amount of spawning and rearing area by controlling the wetted perimeter and the depth and velocity of water. Streamflow also determines stream channel morphology, bed material particle size, and a stream's capacity to transport sediment. These parameters in turn determine the quality and distribution of aquatic habitat types.

Next to flow, water velocity is probably the most important variable in determining the amount of living space for fish. If velocities are unsuitable, no fish will be present. Natural streams have a variety of velocities, some of which are suitable for fish. The velocities suitable for salmonids vary with life stage of the fish, the species, and the season of the year.

Cover. In-stream cover gives fish security from predation and displacement during high flows and allows fish to use portions of a stream they might not otherwise be able to use. Some of the more common cover elements include the following:

- Deep water
- Water turbulence
- Large-particle substrates
- Overhanging riparian vegetation
- Undercut streambanks
- Woody debris
- Aquatic vegetation

The cover requirements of fish change diurnally, seasonally, and by species and life stage. Cover has been correlated to fish abundance and is an important aspect of quality habitat.

Substrate. Streambed substrate gives juvenile fish cover from predators and adverse environmental conditions, serves as habitat for aquatic invertebrates, often provides a substantial component of the fish's diet, and contributes to the quality of spawning, incubation, and rearing habitat.

The interstitial space (voids) between substrate particles provide instream cover. In many streams large-particle substrate is the main cover type along with water turbulence and depth. Small-particle substrates, such as silt and sand, are of no value as cover for fish. Small fish such as newly emerged fry can use substrates consisting of 2-5 cm diameter rocks, whereas larger fish require cobble- and boulder-size material.

Aquatic invertebrates, which are a primary food for fish, are produced in the substrate. Some types of invertebrates are more suited to fine-particle substrates than others. But watershed disturbance and erosion can add fine sediments, which can reduce the abundance of many species of invertebrates, resulting in reduced fish production.

When an adult salmonid selects a spawning site, it is also selecting the incubation environment. Redd (nest) construction displaces fine sediment and organic material from the redd and rearranges larger substrate material such as gravel and rubble, making the site as favorable to egg development as it will ever be. As the incubation period proceeds, redds may become less suitable to developing embryos if fine sediment and organic material are deposited in the interstitial space between particles.

The fine sediment can impede the movement of water and alevins from the redd, and the organic matter can consume dissolved oxygen during decomposition. If organic matter consumes dissolved oxygen faster than the reduced intragravel water flow can replace it, the embryos or alevins will asphyxiate. The amount of fine sediment deposited and the depth to which it intrudes depends on the size of substrate in the redd, flow conditions in the stream, and the amount and size of sediment being carried.

Energy Flow and Stream Productivity. Stream and terrestrial ecosystems are closely linked. The flow of water, sediment, nutrients, and organic matter from the surrounding watershed shapes the physical habitat and supplies energy and nutrients to the stream community. Activities of the many components of the stream community influence the flow of energy from primary production to decomposition. As predators, salmonids are influenced by energy-flow processes operating at all levels in the stream ecosystem (Murphy and Meehan 1991).

Streams vary in productivity, largely in response to nutrients and energy. Energy comes to the stream community from two main sources: photosynthesis by aquatic plants in the stream and decomposition of organic matter imported from upland and riparian areas outside the stream. Imported energy sources contribute organic matter to a stream by four main pathways: litter fall from streamside vegetation, ground water seepage, soil erosion, and fluvial transport from upstream. In addition, animals can contribute important amounts of organic matter and nutrients.

Streamside vegetation provides large amounts of organic matter when leaves, needles, and woody debris fall into the stream. Leaves and needles usually contribute most of the readily usable organic matter in woodland streams.

As much as 25% of a stream's total imported organic matter may enter dissolved in ground water. But the nutritional value of this dissolved organic matter is generally low, and this organic matter does not contribute much energy to the stream community (McDowell and Fisher 1976; Klotz and Matson 1978). As with ground water, most dissolved organic matter from soil erosion offers little nutritional value to the stream community.

Fluvial transport of organic material from upstream reaches becomes an energy input to downstream reaches. Upstream reaches can supply up to a third of the total organic input to small streams and nearly all the organic matter in large rivers (Vannote and others 1980). The source of fluvial transport is generated in the stream itself by invertebrate processing of detritus

(Webster and Golladay 1984 in Meehan 1991) and algal cells detached from the streambed (Swanson and Bachmann 1976).

Animals transport organic matter to streams in many ways. Terrestrial insects drop into streams and are eaten by fish. Drift of aquatic insects export matter downstream. And mature insects can move matter upstream by flying. Beavers carry woody debris to streams, and grazing and browsing mammals transfer matter by feeding in uplands and defecating in the floodplain. Annual spawning runs of anadromous salmon (and decay of carcasses) can contribute large amounts of organic matter and nutrients to some streams and historically contributed a large input of organic material and nutrients to streams.

Influence of Riparian Vegetation. Watershed and riparian community condition directly influences the condition, quality, and maintenance of aquatic habitat. Riparian plants do the following:

- Filter sediments and nutrients.
- Create shade.
- Stabilize streambanks.
- Provide cover in the form of large and small woody debris.
- Produce leaf litter energy inputs.
- Promote infiltration and recharge of the alluvial aquifer (Orth and White 1993; Wesche 1993).

As a result of these functions, spawning beds for salmonids and microhabitats for macroinvertebrates remain relatively free of damaging fine-sediment deposits. Riparian vegetation reduces sedimentation of pools, thereby maintaining water depths and structural diversity of the channel. The slow release of water stored in aquifers augments base flow levels throughout the year. The interaction of streamflow and riparian features, such as living vegetation and large woody debris, often form such complex off-channel habitats as backwaters, eddies, and side channels. These areas of slower water give critical refuge during floods for a variety of aquatic species and serve as rearing areas for juvenile fish.

The bank stabilizing function of streamside vegetation not only helps reduce erosion and influence channel morphology but also acts to supplement instream cover by contributing to the development of undercut streambanks and by providing overhanging vegetation. Well-vegetated stream channels and stable streambanks help reduce the turbidity and channel scouring of high runoff and can also enhance primary production.

In Alaska and other cold regions, well-vegetated stream channels help reduce the formation of aufeis (ice formed by the overflow of water onto existing ice). Aufeis can do the following:

- Decrease primary productivity.
- Delay riparian plant growth.
- Increase erosion.
- Tie up water as ice during critical low-flow periods.

- Cause the formation of new stream channels by blocking channels (Churchill 1990; Michel 1971; Slaughter 1990).

Threatened, Endangered, and Special Status Species–Status and Trend

The population status of nonanadromous and anadromous fish species on BLM-managed land ranges from excellent to poor. Many states in the study area show a declining trend in the populations of native species. Alaska has no special status fish species, and Pacific salmon and steelhead have experienced record high abundance in the recent decade (Nehlsen 1996). Conversely, in Oregon, 25 nonanadromous species on BLM-administered land were listed as threatened, endangered, candidate, or sensitive as of 1991, and 79% of the salmon and steelhead stocks are at some risk of extinction (BLM 1996a, 1991a).

In a literature review, Nehlsen and others (1991) found that 106 anadromous salmonid populations are extinct in the Pacific Northwest and that 214 other stocks of Pacific salmon and steelhead are facing high or moderate risk of extinction, or are of special concern. A closer look by Higgins and others (1992), Nickelson and others (1992), and the Washington Department of Fisheries and others (1993) further delineated those stocks listed by Nehlsen and others (1991) and determined that as many as 512 anadromous salmonid stocks inhabit the Pacific Northwest. Of the 512 stocks found, 243 occur on BLM-managed land, and 173 (71%) are at some risk of extinction (BLM 1996a).

In addition to anadromous species, many other rare and imperiled freshwater fishes reside in BLM-managed waters. In a state-by-state study of the status of freshwater fish in the United States, Warren and Burr (1994) found the number of native fish that are endangered, threatened, or of special concern to be particularly high in Nevada (43 species, 100% of the native fishes), California (42 species, 72%), Oregon (25 species, 44%), Arizona (22 species, 85%), and New Mexico (20 species, 30%). In these states BLM manages thousands of miles/acres of stream and lake habitat.

Williams and others (1989) documented a 45% increase in the number of freshwater fishes in North America warranting special protection because of their rarity when compared with conditions 10 years earlier. They listed 147 taxa of special concern, 114 threatened, and 103 endangered. Of these 364 taxa 31% occur in waters under BLM administration. As of 1991 BLM-managed lands had 39 species of fish that were listed as threatened or endangered and 73 species considered to be candidate, BLM sensitive, or state-listed species (BLM 1991a).

In the past 6 years 26 species of fish have been added to the threatened and endangered list, bringing the total number of threatened or endangered fish on BLM-managed land to 65. These species inhabit BLM lands in all states except Alaska. (Appendix F lists threatened, endangered, and proposed candidate species.)

About 93% of the declines in fish populations are attributed to habitat loss and destruction (Williams and others 1989). But mining has not caused all habitat loss and destruction.. Physical and chemical degradation results from many factors, including dams and diversions;

chemical pollution; urban and agricultural encroachment; and damage from timber harvesting, livestock grazing, and mining (Williams 1997a).

Effects of Mining on Aquatic Resources

Since the mid-1800s mining has impaired thousands of miles of aquatic habitat in the western United States (USFS 1993a; James 1989, 1991; Chertudi 1986; Kleinman 1989, Kimball and others 1995; Finlayson and Verrue 1980; Canfield and others 1994). It is difficult to measure the amount of BLM-managed aquatic habitat that has been disturbed since 1981. The data for BLM-managed land does not distinguish between disturbance to aquatic habitat and disturbance to upland areas. In addition, information on disturbance does not include indirect offsite impacts that can result from changes to water quality or quantity or to stream morphology.

Finally, the quality of BLM-managed aquatic habitat may be impaired by mining on non-BLM-managed lands upstream or on adjacent uplands. Between 1981 and 1997, placer mining altered an estimated 450 miles of stream on BLM-managed land. This estimate considers only direct stream channel disturbance by placer mining and not indirect offsite impacts (e.g. downstream water quality impacts). Nor does this estimate consider disturbance or impacts stemming from exploration; strip, pit, or underground mining; or independent mill sites, all of which would increase the estimate. The estimate of disturbed stream length above was derived by converting past acreage estimates for placer Notice- and Plan-level operations to miles of stream channel by dividing by an average width. The average widths (300 feet for Notices and 600 feet for Plans) were obtained from BLM patent applications.

Physical Impacts. Mining, particularly placer mining, often directly alters or relocates stream channels. This alteration destroys aquatic habitat. Placer mining often diverts streams into bypass channels while the original channel is mined. Streams are then returned to newly built (reclaimed) channels once mining is complete. Stream bypasses and newly reclaimed stream channels are often built with or result in different geometry and physical characteristics (e.g. flood prone and bankfull widths, bankfull depth, sinuosity, slope, entrenchment, and substrate size) than that of the natural unmodified channel.

The difference is often due to the removal of streamside vegetation and other hard structural elements that defined the natural channel morphology. As a result, bypasses and newly reclaimed channels are often straighter, have a higher gradient, and thus have more energy than the natural channel. In addition, new channels often lack the diversity of habitats (pools, glides, riffles) and cover components (undercut bank, overhanging vegetation, large woody debris). This diversity enhances the quality of habitat in natural unmodified channels.

Altering surface hydrology often results in stream conditions that no longer provide suitable habitat to species or life stages of fish and other aquatic organisms present before disturbance. For example, increased stream flow may result in water velocities that do the following:

- Cause involuntary downstream displacement and mortality of juveniles.

- Result in scour-related mortality of eggs and alevins.
- Accelerate streambank erosion.
- Create less desirable conditions for adult fish.
- Deplete large woody debris and organic material over the long term.

The enlargement of stream channels may result in a shallow, low-velocity aquatic environment during periods of low flow. This new environment then could result in crowding, loss of spawning habitat, reduced primary and secondary productivity, increased vulnerability to predation, and increased sedimentation (Swanston 1991; Hicks and others 1991; National Research Council 1992; Stouder and others 1997).

Mine development may also alter the natural input rate of sediment, organic matter, and nutrients to aquatic systems. Mine sites can include open pits, heap and dump leaches, waste rock and overburden piles, tailings piles and dams, haul roads and access roads, ore stockpiles, vehicle and equipment maintenance areas, and exploration and reclamation areas. These areas are all major sources of erosion and sediment.

The main factors influencing erosion on mine sites include the volume and velocity of runoff from precipitation, the rate of precipitation infiltration through the soil, the amount of plant cover, the slope length or the distance from the point of origin of overland flow to the point of deposition, and operational erosion control structures (EPA 1997).

Sediment delivery exceeding natural levels can greatly disrupt the aquatic environment. Excessive fine sediment deposited in streams can alter stream channel morphology, substrate composition, and surface-ground water interaction (Madison 1981; Bjerklie and LaPerriere 1985; Rosgen 1996). These changes can lead to decreased survival of fish in the egg and alevin stages; decreased density, biomass, and diversity of aquatic insects; and decreased primary production (Cordone and Kelley 1961; Cooper 1965; Van Nieuwenhuyse 1983; Webber and Post 1985; Lloyd and others 1987; Buhl and Hamiltion 1990).

Suction dredging has been shown to locally reduce benthic (bottom dwelling) invertebrates (Thomas 1985; Harvey 1986) and cause mortality to early life stages of fish due to entrainment by the dredging equipment (Griffith and Andrews 1981). Suction dredging may also do the following:

- Destabilize spawning and incubation habitat.
- Remove large roughness elements such as boulders and woody debris that are important for forming pool habitat and that can govern the location and deposition of spawning gravels (Harvey and Lisle 1998).
- Increase suspended sediment, decreasing the feeding efficiency of sight-feeding fish (Barrett and others 1992).
- Reduce living space by depositing fine sediment (Harvey 1986).
- Cause fish to avoid certain habitats because of their response to divers (Roelofs 1983).

On the other hand, suction dredging may temporarily improve physical fish habitat by creating deep pools or by creating more living space by stacking large unembedded substrate (Harvey and Lisle 1998). In general, invertebrates and periphyton all rapidly recolonize small patches of new or disturbed substrate in streams as long as the area of disturbance is not so widespread as to limit the number of organisms available to recolonize (Griffith and Andrews 1981; Thomas 1985; Harvey 1986). In addition, dredge tailings may increase spawning sites in streams lacking spawning gravel or in streams that are armored by substrate too large to be moved by fish (Kondolf and others 1991). In some cases the reduction in the feeding efficiency of fish may be offset by reduced visibility and the corresponding reduced risk of predation at moderate levels of suspended sediment (Gregory 1993).

The current state of knowledge of suction dredging and its impacts on aquatic resources suggests that the practice could be either detrimental or beneficial, depending on site-specific use by aquatic organisms and physical habitat limitations. In either case, the location and timing of suction dredging must be evaluated to determine potential impacts on fish and other aquatic resources.

Water Quality and Quantity Impacts. Water pollution from acid rock drainage is one of the most serious and persistent problem facing the mining industry. Acid rock drainage can result from the exposure to water and air of material containing metallic sulfides such as pyrite, saphalerite, and galena.

The chemical reaction that produces acid rock drainage occurs naturally due to weathering. But mining can accelerate the reaction by exposing large amounts of sulfide-bearing material. When exposed, these sulfide minerals readily oxidize in water to form sulfuric acid.

Runoff and seepage from sulfide-bearing material may have a low pH (2.0-4.5), which is directly toxic to most forms of aquatic life and mobilizes (dissolves) toxic metals. Water can carry the toxic metals many miles from their source (Johns and Moore 1985). Although testing methods used to predict acid rock drainage have improved in recent years, there is often substantial uncertainty about the predictions. Moreover, new mines can develop unpredicted acid rock drainage after only a few years of operation or after mine closure (EPA 1997).

Acid rock drainage from both abandoned and active mines has damaged many miles of aquatic habitat. On Forest Service land alone, acid rock drainage has impaired an estimated 5,000 to 10,000 miles of streams (EPA 1997). Metal mining materials and wastes that have the potential to generate acid rock drainage include tailings, waste rock, overburden, and spent ore from heap and dump leach operations. Equally or more important at some sites are the pit walls at surface mining operations and the underground workings of underground mines. Acid rock drainage can also occur in pit mining lakes formed.

In Nevada over the next 20 years mining is predicted to form 30 pit lakes. When filled by ground water, these lakes will contain more than 1 million acre-feet of water that one researcher predicts will likely be permanently toxic to wildlife (Miller and others 1996). The potential threat to aquatic life from contaminants mobilizing in a pit lake or in ground water next to a pit lake can vary from site to site.

Common rates of ground water movement are 150 to 200 feet per year in fine to medium sands and 1,000 to 2,000 feet per year in gravels. The actual ground water flow rate depends on the hydraulic conductivity of the aquifer and the ground water gradient. Contaminants such as metals may travel at slower rates than ground water depending on the constituent and its interaction with the soil type (Grabert 1998). In addition, hydrodynamic dispersion, which spreads the contaminate plume in a direction perpendicular to the flow, will affect how big the plume becomes.

Metals are naturally present in all surface waters and are required by aquatic organisms in trace amounts. Mining may cause the concentration of dissolved metals to exceed the natural background levels within streams and lakes. The chief metals released to streams and lakes by mines are arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, and zinc. At high concentrations, metals may kill aquatic organisms. At prolonged exposure to sublethal concentrations of metals, organisms may experience behavioral changes and reproductive failure (Chapman 1973).

Metal precipitates that originate in some waste rock dumps can be highly mobile and be transported long distances in streams. Metals in this solid phase have resulted in reduced density and diversity of aquatic invertebrates and food chain contamination in areas removed (more than15 miles) from the contamination source. Metal-contaminated diets have been found to cause reduced growth, histopathological (tissue change) effects, and reduced survival in trout. Exposure to metals in the diet have caused greater adverse effects to trout than exposure to metals in solution (Farag and others 1994; Ingersoll and others 1994; Kemble and others 1994; Moore and others 1991; Woodward and others 1994).

Cyanide is toxic in its free form, hydrogen cyanide (HCN), as the cyanide ion (CN^-), and as breakdown compounds such as cyanates, thiocyanates, chloroamines, cyanogen chloride, and metal-cyanide complexes (Moran 1998). Although free cyanide does not persist in the natural environment and does not bioaccumulate through the food chain, many of the breakdown complexes do bioaccumulate, and some are especially toxic to fish. Consequently, the exposure of surface waters to cyanide compounds resulting from leaching, seepage, accidental discharge, emergency releases, and runoff can be harmful or lethal to aquatic life.

Since the 1980s, many major cyanide spills have occurred. On the Zortman-Landusky mine in Montana, cyanide has been detected in every sample of ground water collected between 1992 and 1995 from Montana Gulch. The cyanide contamination at this location was attributed to a pipeline rupture below a leach pad in 1992 (BLM and Montana Dept. of Environmental Quality 1996). The most notable cyanide spill occurred in South Carolina in 1990, when a dam failure released 10 million gallons of cyanide solution, killing fish for 50 miles downstream from the mine (EPA 1997).

Many native fish have evolved according to specific patterns of annual and seasonal precipitation, runoff, and stream flow. Most of these species have enough flexibility in the timing of their maturation, migration, and reproduction life stages to allow them to survive temporary periods of unfavorable conditions. But mining can change the natural surface and subsurface hydrology to such an extent that some species cannot survive.

Surface mining commonly strips land of its vegetation and topsoil. Such a condition can lead to the following:

- A decreased water infiltration capacity of the remaining soils.
- Increased overland flow.
- Decreased lag time between precipitation events and runoff.
- Increased streamflow over short periods of time.

Any increase in overland flow, particularly over disturbed areas, will increase the amount of sediment introduced into a stream. The increased overland flow and sediment input places hydrological stresses on the receiving stream channel and will eventually lead to erosion, destabilization, and enlargement of the stream channel.

Water consumption is another aspect of open pit mining that threatens aquatic resources. Because surface and ground water are inextricably connected, dewatering of aquifers by large open pit mines can change surface flow patterns. As the amount of water being intercepted and pumped from the mine increases, the size of the area subjected to a lowered water table increases. In some cases the area influenced by dewatering can extend for miles (Crompton 1995).

After mining (and pumping) is complete, many decades may be needed for the ground water to replenish (EPA 1997). In some cases more than a century may be required to reestablish the ground water supply to that of predisturbance condition (Manning 1994; BLM 1996d). In other cases dewatering of alluvial aquifers could result in the permanent loss of water storage capacity due to compaction of the aquifer (EPA 1997). As a result, flow to surrounding springs, streams, and lakes may be reduced or lost with direct consequences to aquatic species that rely on the affected water source.

In arid environments like Nevada, ground water fed springs may contain native invertebrates such as the spring snail. Loss of these unique habitats from dewatering is of particular concern because many of the species occupying these spring-fed areas are just becoming known, and in many cases no measures have been developed to protect them.

Aquatic and wetland habitats downstream of the immediate area influenced by mine dewatering may also be at risk due to the increased demand placed on water resources. An example of this influence may be seen in the Humboldt Wildlife Management Area, a terminal wetland in west-central Nevada. Agricultural water diversions and drought have reduced water delivery to the wetlands over several years.

Over the last 10 to15 years, the development of large open pit mines and related increase in population have placed new and increased demands on water within the Humboldt River Basin. These demands in turn may further reduce water delivery to the wetland and result in a corresponding decrease in water quality due to concentration of salts and other dissolved constituents.

Reclamation Practices. Reclamation under the 3809 regulations has evolved since1981. In the early1980s placer mine reclamation usually consisted of relocating the stream channel back into the lowest part of the valley on a bedrock substrate, followed by recontouring the tailings into the surrounding topography by pushing them uphill away from the stream channel and floodplain. Any available topsoil was respread over the graded tailings. Many of the sites had been mined previously or historically, and the topsoil had been lost. Occasionally operations seeded sites after applying the topsoil. But more commonly sites were left to revegetate through natural succession. Similarly, limited grading and occasional seeding often reclaimed nonplacer operations.

Today, more attention is paid to stream channel design. In some of the more recent examples of placer reclamation, newly built stream channels are modeled after the natural system or a system with similar gradient, sinuosity, dimensions, and flow. Revegetation is still usually left to natural processes, especially in Alaska. In nonplacer reclamation, seeding is now standard practice. Seeds are usually a mixture of grasses, forbs, and shrubs, and increasingly consist mostly or entirely of native species.

Unfortunately, the success of the existing regulations at rehabilitating aquatic habitat has been poor, mainly because past reclamation practices. Much of the recent emphasis on proper stream channel design has been applied only at a few mines and has yet to be evaluated. In addition, past reclamation practices did not commonly replace lost instream cover components or hard structural elements that provide habitat diversity. Many of these elements (e.g. logs, boulders, root wads) are not suitable for all channel types (Rosgen 1996) and may create unwanted hydrological stress on new stream channels, resulting in undesirable channel adjustments. Several years may be needed for a new channel to reestablish equilibrium and stability and allow lost cover components to be installed and habitat diversity to be restored.

Most of the aquatic habitat disturbed since 1981 remains in an impaired condition. Field evaluations by BLM staff and Carlson and Karle (1997) reveal that operations have rarely achieved reclamation, including reestablishing hydrologically stable drainages, properly functioning floodplains, and riparian zones, and a diverse mix of habitat types and cover components. In recent years, maintaining good water quality has been less of a problem. But during heavy precipitation or runoff, aquatic organisms may be exposed to harmful or fatal levels of sediment, turbidity, metals, and other toxic chemicals.

Environmental Consequences

Alternative 1: No Action

The removal of streamside riparian-wetland vegetation during mining would result in loss or degradation of aquatic habitat until proper functioning condition could be reestablished. In general, the time required for riparian-wetland areas to attain proper functioning condition would be dictated by natural processes and could require from 25 to 50 or more years, depending on site conditions, including soil, aspect, climate, and external disturbance factors such as livestock grazing.

Dewatering of mines could expose aquatic organisms to (1) artificially elevated levels of stream discharge during mine operation and (2) insufficient stream flow during aquifer recharge following mining. Water quality standards should be met during periods of low

flow, but increased sedimentation and elevated turbidity would be expected during storms due to stream channel erosion and lack of stabilizing vegetation on disturbed sites. Because of the need for long-term or perpetual water treatment and maintenance of impoundments, aquatic life would continue to be threatened by
runoff, seepage, ground water contamination from spent ore from heap and dump leach operations, tailings, waste rock, overburden material, pit walls, pit lakes, and underground mine workings

Suction dredging might affect fish communities by doing the following:

- Reducing local food supply (invertebrates) and feeding efficiency.
- Destabilizing spawning, incubation, and rearing habitat.
- Injuring or killing early life stages.

These impacts would continue, undetected and unregulated, because BLM typically does not require a Notice or Plan of Operations.

Threatened and endangered species would be protected under the Endangered Species Act. But as with more common species, BLM- and state-listed sensitive species would continue to be displaced, injured, and killed.

Alternative 2: State Management

Impacts to aquatic habitats and communities would vary by state because of the wide range of regulatory requirements. For example, California has a highly detailed and complex regulatory system that recommends that wildlife habitat be returned to its premining condition, if not a better condition, unless the proposed end use precludes habitat. In addition, California requires the preparing of an environmental impact report (EIR) for any project that might have a substantial impact on the environment. The EIR is similar to the environmental analysis and documentation required under the National Environmental Policy Act (NEPA). In contrast, Nevada, defers to BLM reclamation standards and does not require preparing any NEPA-like documentation. Regardless of the states' regulatory requirements, the requirements under which a mine is operated are mainly determined by negotiation between the mine operator and the state (McElfish and others 1996). In general, the nature, extent, and duration of impacts under the State Management Alternative would be similar to Alternative 1.

As under Alternative 1, common species and BLM- and state-listed sensitive species would continue to be displaced, injured, or killed except for possibly in California and Oregon, which require consultation for state-listed species.

Alternative 3: Proposed Action

The Proposed Action would require operators to minimize disturbance to fish and many of the habitat parameters affecting the aquatic community. Such parameters include water quality and quantity and riparian areas. This requirement should result in less aquatic habitat being directly disturbed in areas outside the ore body. In the past, areas outside the ore body may have been disturbed to develop access, waste dumps, or other support activities for ore extraction. Where disturbance could not be avoided, the nature and duration of disturbance would be similar to that under Alternatives 1 and 2.

Some of the unavoidable disturbance to aquatic habitat would be offset by riparian-wetland mitigation. Because of BLM's ability to set the time frame (goal) for riparian recovery (and thus the level of reclamation effort applied to riparian restoration), the time needed under Alternative 3 to rehabilitate aquatic habitat to a level where it is healthy, properly functioning, and self-maintaining might be slightly less than under Alternatives 1 or 2. Over time, offsite riparian mitigation or replacement required under the Proposed Action should avoid the loss of riparian vegetation but still might not address the spacial distribution and functional processes provided by natural riparian systems (Pastor and Johnston 1992; North Carolina State University 1998).

Suction dredging would continue to affect fish communities by reducing local food supply (invertebrates) and feeding efficiency. But most impacts on early life stages of fish and of spawning, incubation, and rearing habitat could be avoided or reduced by proper timing or specifying certain areas as off limits to dredging.

Threatened and endangered species would continue to receive the same level of protection that they do now under the Endangered Species Act. Displacement, injury, and mortality of common and BLM- and state-listed sensitive species should be less where habitat disturbance outside of the area of the ore body could be minimized by such actions as relocating access roads out of riparian-wetland areas. Sensitive species would continue to be affected near the ore body.

All mining would require Plans of Operations. BLM's ability to require baseline information for Plan-level operations should help increase the success of fisheries rehabilitation. Such information might include detailed stream channel geometry, aquatic habitat composition, and documentation of species and lifestage presence or absence. Exploration disturbing less than 5 acres would be allowed under a Notice. But bonding of Notice-level operations and the requirement to meet the performance standards to prevent unnecessary or undue degradation should help ensure that areas are rehabilitated.

Bonding requirements under Alternative 3 would not address unplanned events such as spills or facility failures or unforeseen changes to water supply or water quality. Therefore, funding of corrective action would fall to BLM. In areas having unusually high-value aquatic resources, BLM might deny mining if an operation could not provide suitable mitigation.

Alternative 4: Maximum Protection

The substantial irreparable harm standard in combination with the 10-year habitat restoration time requirement would make Alternative 4 far better protect aquatic resources and reduce disturbance more than the other alternatives.

The nature of impacts to aquatic resources under Alternative 4 would be similar to that under the other alternatives. But under Alternative 4 the habitat restoration time requirement (and the corresponding increase in reclamation effort to meet this requirement) would greatly reduce the duration and extent of impacts. As under the other alternatives, the removal of streamside riparian vegetation during mining would degrade aquatic habitat and communities by the following:

- Increasing stream channel erosion and stream sedimentation.
- Promoting altered channel morphology.
- Decreasing water quality.

In addition, riparian vegetation would lose its role of providing nutrient and energy input, stream shading, instream cover components, streambank stability, and aquifer recharge. But if the operator could not project successful restoration of aquatic and riparian-wetland habitat to proper functioning condition (including suitable water supply) within 10 years after mining, BLM could deny the proposal to mine.

In addition to the requirement to restore aquatic habitat to proper functioning premining condition, all operations under Alternative 4 would be bonded to cover unplanned events.

Runoff, seepage, and ground water contamination from mining would no longer pose as great a threat to the aquatic community because of the ability to designate certain acid-producing deposits as unsuitable for mining. The result would be that acid-producing conditions would not occur in some areas, and metals would not be released into ground or surface water that accompanies low-pH conditions. In some instances, however, modeling would not foresee the potential for a deposit to produce acid (and metals).

Impacts from suction dredging would be similar to those under Alternative 3 and would mostly be avoided.

Alternative 4 would reduce or avoid the displacement, injury, and mortality of BLM- and state-listed sensitive species by the requirement to treat these species as threatened and endangered under the Endangered Species Act.

Alternative 5: NRC Recommendations

Under Alternative 5 mining would require Plans of Operations, and exploration disturbing less than 5 acres would require Notices, as under Alternative 3. Notice-level bonding would help ensure that performance standards are met, but bonding would not cover unplanned events that could degrade aquatic resources. The definition of unnecessary or undue degradation would not include the substantial irreparable harm standard, and BLM could not deny mining in areas with high-value aquatic resources. Under Alternative 5 aquatic resources would receive similar protection as under Alternative 1.

Cumulative and Residual Impacts

Unavoidable direct disturbance to aquatic and riparian habitat would require many years (25 to 50+) to recover to healthy functioning condition. This recovery period might be prolonged in some areas, depending on how the land is used after reclamation. For example, livestock grazing might extend the time for streamside riparian vegetation to become established. Some of the mining, especially placer mining, might take place on previously worked claims, setting back aquatic/riparian habitat recovery by the number of years between the previous and future disturbance.

In summary, placer mining disturbed an estimated 450 miles of stream channels between 1981 and 1997 and is predicted to disturb a similar amount for the 20-year analysis period. In addition, direct and indirect disturbance to aquatic-riparian habitat from exploration; strip, pit, or underground mining; or independent mill sites could substantially increase this estimate, possibly doubling it. The result would be an estimated total cumulative disturbance of 1,500 to 2,000 miles of aquatic/riparian habitat in addition to the thousands of miles of aquatic/riparian habitat still being affected by historic operations.

All alternatives might have residual impacts from operations causing acid production, and might result in the associated need to treat water and maintain impoundment facilities for long periods, or perpetually. In addition, erosion, the altering of surface hydrology, and the introducing of sediment beyond the ability of streams to transport it would result in channel instability and undesirable channel adjustments that might affect streams over much of their length. Channel adjustments, in turn, could degrade offsite aquatic-riparian habitat.

In areas subjected to large-scale ground water withdrawals, many decades may be required before ground water levels recover and the connection to dependent streams, springs, and seeps is reestablished. The recovery of ground water levels may be prolonged by other competing uses of the water.

WILDLIFE RESOURCES

Affected Environment

A great diversity of aquatic (amphibians) and terrestrial animal species inhabit federally managed public lands. Equally diverse are the vegetation communities that serve as habitat for these unique assemblages of aquatic and terrestrial species. Federal lands across the West provide seasonal or permanent habitat for more than 3,000 species of amphibians, reptiles, birds, mammals, and fish.

Amphibians and Reptiles

Information on the distribution and abundance of amphibians on BLM-managed lands is limited. Amphibians are difficult to survey because localized populations fluctuate widely over time, and trends are difficult to determine. Moreover, distribution and abundance are tied closely to specific substrates and microhabitat conditions. Most amphibians require moist sites or standing to flowing water for egg-laying and larval development. Amphibians mainly live in riparian, wetland, and aquatic habitats, but a few inhabit grasslands and coniferous-deciduous forests.

Amphibian populations have declined in the past decade (Vitt and others 1990). Although no single factor has been found to cause declines, many factors are suspected. The dramatic loss of wetlands to land development and farming has directly affected amphibians. Introducing exotic species such as bullfrogs, trout, and carp can reduce amphibian populations through predation or destruction of food and breeding habitat. Some species have a high tolerance for changes in water quality. Others, such as the Idaho giant salamander, do not. The following actions may alter water quality enough to harm adults, reproduction, and food sources (Freda and others 1991; Quigley and others 1997):

- Runoff from roads.
- Use of herbicides and pesticides.
- Increased sedimentation from mining, farming, forestry, and recreation.

As with amphibians, information is limited on population distribution and abundance of reptiles on BLM-managed lands. Like amphibians, reptiles are closely tied to microhabitat conditions such as slope and aspect.

Birds

The Migratory Bird Treaty Act of 1918 as amended in 1972 makes it unlawful to "take" any migratory bird, any part of a bird, or nests and eggs of such birds (see Appendix C). The Bald Eagle Protection Act also makes it unlawful to "take" any bald or golden eagle, any part, or nests and eggs of such birds.

Song Birds and Upland Game Birds. In recent years public concern for these birds has risen sharply as a result of population declines. Rich and Beardmore (1997) list 177 species of birds that rated a priority for management attention in one or more of the western states (Appendix F). Federal lands in the western United States constitute an important part of breeding habitat.

Survey data have revealed declines in songbird populations throughout the United States, Canada, and Mexico. Population declines are due to a variety of factors. The main cause is habitat destruction on breeding grounds, wintering areas, and migration routes. But other significant factors include the following:

- Urbanization.
- Habitat fragmentation.
- Predation by domestic cats.
- Parasitism by brown-headed cowbirds.
- Flying into transmission towers and windows.
- Invasions of nonnative plant species.
- Herbicides and pesticides.

Songbirds that breed on public lands can be classified as short-distance migrants, residents, or long-distance (neotropical) migrants. Short-distance migrants may move only slightly, such as shifting elevation. For example, white-breasted nuthatches, mountain chickadees, and American dippers move down in elevation during winter and return to higher elevations in the spring and summer. Other species such as the northern mockingbird, rufous-crowned sparrow, and downy woodpecker may migrate south but remain within the United States during the winter. Resident birds generally remain in one area during the year and do not migrate. The hairy woodpecker, common flicker, horned lark, and black-capped chickadees are examples of residents.

Neotropical migratory birds fly to Mexico, the Caribbean, and Central and South America during the fall to spend the winter. They then return to the United States and Canada during the spring to breed. Neotropical migratory songbirds are some of the most beautiful and commonly recognized birds in the United States. Riparian areas and large tracts of upland native prairie are especially important to songbirds. Some familiar species of migratory birds in the West include the Bullock's oriole, western tanager, rufous hummingbird, lazuli bunting, cedar waxwing, and yellow warbler.

A variety of upland game birds also inhabit public lands. Several are becoming imperiled: sage grouse, Columbian sharp-tailed grouse, mountain quail, and lesser prairie-chicken. The U.S. Fish and Wildlife Service has received petitions for federal listing of each of the these species as threatened or endangered. Other upland game birds on BLM-managed lands include the ruffed grouse, blue grouse, greater prairie-chicken, California and Gambel's quail, willow and white-tailed ptarmigan, several dove species, and wild turkeys. Ring-necked pheasants and chukar partridge are both exotic upland game birds introduced from Eurasia.

Upland game birds occupy many plant communities managed by BLM. Sage grouse occupy habitats that are predominantly sagebrush steppe. Sharp-tailed grouse prefer a prairie or low-shrub and grass community. Ruffed grouse use brushy woodlands along streams and around springs. Their daily and seasonal habitat needs are typically more specific. Brood rearing requires wet meadow habitats and other habitat types that are ideal for producing forbs and insects.

Nationally, populations of greater prairie chickens, Alaskan sharp-tailed grouse, and wild turkeys are increasing. The remaining species are almost evenly split between stable and declining status. Although weather plays a major role in the population dynamics of upland game birds, urbanization and industrialization have eliminated millions of acres of habitat. Farming, grazing, logging, fire, mineral and energy development, and nonnative plant invasions have all contributed to the loss of habitat.

Waterfowl. Waterfowl include ducks, geese, and swans. Most waterfowl breed in Canada, Alaska, and the northern United States and migrate to overwinter in Mexico and the southern United States. Important for the reproductive success and survival of waterfowl is a complex of diverse wetland habitat types that include a variety of emergent vegetation and open water areas.

Regardless of the habitat type, extensive areas of habitat have deteriorated or been destroyed and rendered unsuitable for waterfowl. Many waterfowl species have suffered as a result of shrinking habitats, exacerbated by long periods of drought combined with predation. Habitat losses have concentrated waterfowl populations and contributed to the rapid spread of mortality from diseases such as avian cholera and botulism.

Water quality affects the aquatic food chain and has major effects on waterfowl productivity. For example, increasing wetland acidity reduces both emergent vegetation and invertebrate diversity and biomass.

Shorebirds and Wetland-Dependent Migratory Birds. Shorebirds are found not only in coastal regions but throughout the Great Plains and deserts of the western United States–areas that have high evapotranspiration rates. Most shorebirds nest on the arctic tundra, including millions of pairs on public lands in Alaska. Shorebirds generally nest in upland grasses or gravelly areas near semipermanent to permanent wetlands and feed on invertebrates using mudflats exposed by receding water. Common shorebirds include sandpipers, plovers, killdeer, herons and egrets, phalaropes, avocets, rails, dowitchers, and willets. Loons, coots, and grebes require permanent wetland habitats. As with waterfowl, wetlands are important to the future populations of these species.

Raptors. Eagles, hawks, falcons, owls, and vultures are collectively known as raptors, or birds of prey. Compared to most other animal groups, raptors naturally exist at relatively low population levels and are widely dispersed within their habitats. Like the wolf, mountain lion, and grizzly bear, raptors are top predators and represent key species for determining the condition of a variety of ecosystems. Changes in raptor status typically reflect the availability of their prey species (mammals, birds, reptiles). Population changes also may suggest environmental conditions.

Raptors are a subgroup of land birds (see above) but have several special considerations. First, they are more sensitive to disturbances around their nests than are other landbirds because raptor territories are large and their populations are much smaller than those of other landbirds. Second, raptors are susceptible to direct mortality through both electrocution and shooting. Finally, because raptors are at the top of the food chain, they tend to be more vulnerable to contaminants. This vulnerability is related to higher levels of exposure due to bioaccumulation or biomagnification of some contaminants.

Small Mammals

Small mammals (rodents and insectivores) inhabit almost every kind of habitat in North America. Some species, such as deer mice, are common and widespread in many habitats. Others are found only in certain parts of the country or in limited, specific habitats. Beaver are a habitat-limited species because they require riparian or other aquatic communities. Rodents and insectivores are a major source of food for such predators as bobcat, coyote, fox, and badger, and are ecologically important to plant communities. Land uses that threaten one small-mammal species may benefit another.

Bats

Although information on bat species and populations on BLM-managed lands is limited, general studies and surveys are quickly filling this void. The involvement of Bat Conservation International through an agreement with BLM (March 1993) has significantly increased the knowledge base.

Bat populations are declining throughout the United States as a result of deforestation, agricultural development, and human disturbance of caves. Although people generally associate bats with caves, bats may occupy a variety of habitats, including trees and cliffs. Many bats have occupied abandoned underground mines, which often provide microhabitats similar to caves.

Declines in bats pose serious ecological and economic impacts. Bats are the main predators of vast numbers of nocturnal insects, which include many agricultural and forest pests. Bats are also important pollinators and seed dispersers for southwest desert plants. The Western Bat Working Group (1998) developed a matrix of regional priority species (Appendix F) to give states, provinces, federal land management agencies, and interested organizations better information on the overall status of bat species in western North America.

Carnivores

Populations of large carnivores are decreasing (Weber and Rabinowitz 1996; Clark and others 1996a, 1996b; Noss and others 1996). Large carnivores such as grizzly bears, gray wolves, mountain lions, wolverines, and coyotes are some of the most persecuted of all North American wildlife. Large carnivores have large home ranges and require large prey populations. Therefore, they require large, intact ecosystems to meet their general habitat requirements. One land development action, like clear cutting or a housing development, may only slightly affect a large-carnivore population, but the cumulative effects of multiple actions can be extremely harmful.

Carnivores can be either habitat generalists or habitat specialists. Larger species tend to use a variety of habitats. For example, mountain lion, coyote, black bear, and grizzly bear (habitat generalists) are tied to the movements of ungulates, berry production, and spawning runs of fish, and are therefore better adapted to changing environments (habitats). American martens and fishers (habitat-limited carnivores) require late-successional coniferous forests. River otter and mink depend on riparian habitats.

Predator populations are known to increase and decrease in response to prey availability. For example, a lynx's diet consists mainly of snowshoe hares. Snowshoe hares have a 9- to10-year cycle. Consequently, lynx populations peak every 9 to10 years with a lag year between the time that hare populations decline and lynx realize the declines. The relationship of prey base availability to carnivore populations is one of delicate balance.

Ungulates

Federal public lands are home to millions of big game animals, including large grazers such as elk, moose, mule deer, white-tailed deer, bison, bighorn sheep, woodland and barren-ground caribou, pronghorn antelope, and mountain goats. These native ungulates are important for recreation and subsistence hunting, as prey for large carnivores, and as a reliable source of carrion for scavengers. Like other wildlife, wild ungulates are affected by natural disturbances and human activities.

Threatened, Endangered, Proposed, and Candidate Species

Economic growth and development by a growing human population have depleted the habitat of many species to the extent that they are threatened with extinction. Enacted to conserve threatened and endangered species and the ecosystems on which they depend, the Endangered Species Act of 1973 (Appendix C) separates species into four listing categories:

- **Endangered species** are species in danger of extinction throughout all or a significant portion of their range.
- **Threatened species** are those likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
- **Proposed species** are those for which a proposed rule to list as endangered or threatened has been published in the *Federal Register*.
- **Candidate species** are taxa for which the U.S. Fish and Wildlife Service or the National Marine Fisheries Service has on file enough information on biological vulnerability and threats to support issuing a proposed rule to list but where further action is precluded by higher priority listing.

According to reports from BLM field offices and information compiled by BLM's Washington, Office, 285 species of plants and animals proposed or listed as threatened or endangered under the Endangered Species Act occur on land administered by BLM (Table 3-26). Public lands in each of the 11 western states are managed through state directors and field office managers. The number of proposed and listed species on public lands and acres open to location under the Mining Law within each state are summarized in Table 3-27. Appendix F includes a listing of species on all BLM-administered land compiled from field office reports.

Table 3-26. Numbers of Federally Endangered, Threatened, and Proposed Species on BLM-Managed Lands					
ESA Listing Category	Endangered	Threatened	Proposed Endangered	Proposed Threatened	Total
Mollusks	8	4	0	0	9
Arthropods	7	5	1	0	13
Resident Fish	40	17	4	0	61
Anadromous Fish	5	9	0	3	17
Amphibians	3	1	0	0	4
Reptiles	2	7	1	0	10
Birds	11	11	1	1	24
Mammals	18	5	2	2	27
Plants	51	34	17	18	120
Total	145	90	26	24	285
Source: Data complied from BLM field offices by the BLM Washington Office.					

Table 3-27. Acres of Public Land Open to Location under the Mining Law, and Number of Species on Public Land Protected by the Endangered Species Act							
State	Acres[1] (millions)	Number of Species on Public Land that are Federally Proposed (P) or listed as Threatened (T) or Endangered (E) Under the Endangered Species Act					
		Plants			Animals		
		P	T	E	P	T	E
Alaska	86.5	0	0	0	1	3	1
Arizona[2]	13.6	2	4	10	0	10	27
California	9.1	21	9	18	7	17	28
Colorado	7.3	1	5	5	1	7	14
Idaho	11.2	1	3	0	2	7	12
Montana	6.1	0	0	0	2	4	8
Nevada	47.7	0	7	2	1	8	20
New Mexico	12.4	3	4	7	3	8	20
Oregon/ Washington	13.4	7	3	5	5	19	16
Utah	21.1	1	10	7	3	5	12
Wyoming	15.2	2	1	0	2	4	14
[1] Approximate acres of public land open to mining from Table 1-4 in *Public Land Statistics 1999* (BLM 2000a). Columns 5 and 6 were subtracted from the Grand Total Column to determine acres open to mining. [2] The 1,635,000 acres for the Barry M. Goldwater Air Force Range (Hempel 1999) were subtracted from Column 6 before determining acres open to mining.							

In addition to species listed under the Endangered Species Act, many state wildlife agencies have their own lists of threatened, endangered, or sensitive species. Through policy, BLM manages public lands to conserve federally and state-listed species. Furthermore, BLM state directors are responsible for establishing lists of special status species that occur on public land and for carrying out programs and actions that conserve these species and prevent the need to list them as threatened or endangered under the Endangered Species Act (IM #97-118). According to BLM policy, approved land use must not contribute to the need to list species as threatened or endangered. Species proposed for federal listing as threatened or endangered and proposed critical habitat are to be managed with the same level of protection provided for threatened and endangered species, but formal consultations are not required.

Effects of Mining on Wildlife

Habitat Loss. Habitat loss is one of the main threats to maintaining wildlife diversity and species richness (Wilcove and others 1998; Fahrig 1997; Soulé 1986). All mining results in the loss of habitat at some time and for varying lengths of time (depending upon reclamation). Mining causes short- and long-term impacts to nesting, forage, and thermal and migration cover on mining sites until the disturbed habitats are returned to a condition suitable for a particular species and life stage.

Ireland and others (1994) studied the recolonization of wildlife on a coal strip mine in northwest New Mexico and reported that some habitat that existed before mining was being replaced by reclamation on the Pittsburg and Midway Coal Mining Company's McKinley Mine. Wildlife species selected for study in the newly created habitat included amphibians, reptiles, small mammals, and arthropods.

Vegetation composition and the presence of rocks were determined to be important components for some wildlife species, particularly habitat specialists. Slow regeneration of pinyon and juniper may have excluded some species for decades after mining. Although the study was conducted on a coal mine, similar results would be expected for other surface mining.

Several waterfowl species are apt to occur in any given area or habitat. Because most of these species have distributions that are wide relative to any single mining activity, single actions are generally not likely to noticeably reduce their populations. But the cumulative impact of multiple mines could have significant effects, especially if those effects occur in isolated geographic areas and vegetation types that are population sources for a given species.

Actual or potential degradation of any riparian or wetland area is a serious concern for shorebirds and other wetland-dependent migratory birds, even on a site no larger than a few acres. Even more so than for waterfowl, shorebirds tend to form large aggregations during spring and fall migration. At these times, significant proportions of entire populations may be in one small area (e.g. on only a few acres), where they are vulnerable to harm from contaminated soil or water. Locations used by migratory flocks may vary from year to year, depending on local, regional, and national climatic fluctuations. Large numbers of birds might unexpectedly visit any site with the proper general characteristics.

Mining's destruction of the wetland habitats of waterfowl, shorebirds, and wetland-dependent migratory birds can and are being mitigated to an extent by creating mine-associated wetlands. In a study of emergent wetlands on surface coal mines is Illinois, Horstman and others (1998) and McKinstry and Anderson (1994) reported that mine-associated wetlands with persistent hydrology and large expanses of emergent vegetation may provide habitat to compensate for the loss of natural wetlands.

According to Braun (1998), the developing of open pit mines harms sage grouse numbers and habitats in the short term. But several studies (Montana, Wyoming, Colorado) found some recovery of sage grouse populations after the initial development through the completion of reclamation (Eng and others 1979; Tate and others 1979; Colenso and others 1980; Scott and Zimmerman 1984, Braun 1986). Despite this positive note, Braun (1998) stated that no evidence to date suggests sage grouse populations attain their previous size. A population may need 20 to 30 years to reestablish.

Call (1979) observed that mineral development destroyed raptor nest sites, roost sites, and primary feeding areas. Measures for mitigating loss of raptor habitat have included creating artificial nests, relocating nests, and the retaining highwalls created by mining as new habitat (Postovit and Postovit 1987; Holthuijzen and others 1990).

Abandoned underground mines have become key year-round resources for bats. Due to the colonial nature of most bats, bats are especially vulnerable to the altering or closing of old mines. Loss of a single mine hibernation site can affect a multistate region, eliminating many summer colonies of bats over thousands of square miles.

Contemporary mines are usually in historic mining districts and can have major effects on bats. New sampling methods, such as drilling, may detect ore deposits missed by previous miners, and the ore is typically extracted by open pit mining. Open pit mining often destroy existing adits and shafts. Even exploratory drilling can greatly harm bats if it collapses mine entrances or underground workings (Tuttle and Taylor 1994; Idaho State Conservation Effort 1995).

BLM has demonstrated its commitment to protecting bats and their habitat during a Plan of Operations amendment at the Marigold Mine near Battle Mountain, Nevada. The Plan amendment review revealed that potential impacts to bat habitat were likely (JBR Environmental Consultants, Inc. 1997). A later survey found five species of bats using old mine workings, three of them BLM-listed sensitive species. A mitigation plan was developed. The plan required the company to avoid the impact altogether, minimize impacts by conducting temporary exclusion, and designate more existing habitat for rehabilitation and protection by installing protective gates.

Direct loss of habitat for big game, including both ungulates and carnivores, is an important issue when examining the impacts of surface mining. Habitat loss translates into a loss of forage and protective cover for animals. Ungulates, in particular, are closely tied to three basic habitats: summer range (calving areas), winter range, and migration corridors (Kuck 1986).

Research at a southeast Colorado military training area demonstrated the effect of habitat losses and alterations. Shaw and Diersing (1990) noted that pinyon-juniper and shrub vegetation densities were significantly reduced following military training. Grass species composition also shifted from perennial to annual vegetation, and the amount of bare ground increased. Stephenson and others (1996) found that these habitat alterations influenced mule deer movements.

Researchers (Kuck 1986; Merrill and others 1994) have proposed management recommendations to reduce the effects of mining on big game and large carnivores:

- Minimize habitat loss at mine sites.
- Avoid impacts to migration corridors.
- Protect critical habitats, such as wintering and calving areas.
- Decrease harvests by reducing human-wildlife encounters.

Where mining facilities are built, covered corridors, travel fences, and underpasses and overpasses should be installed to facilitate movement through the mine site (Merrill and others 1994; Noss and others 1996).

Habitat Fragmentation. Habitat becomes fragmented when a large expanse of habitat is transformed into a number of smaller patches. Two components of habitat fragmentation are (1) reduction in total habitat area and (2) redistribution of the remaining area into disjunct fragments (which mainly affect dispersal and immigration rates) (Wilcove and others 1986; Fahrig and Merriam 1994; McCarthy and others 1997). Fragmentation threatens the stability and persistence of wild populations because the size and isolation of remaining habitats increase the probability of extinction through demographic, environmental, or genetic randomness (Wolff and others 1997).

Sage grouse and other sagebrush obligate species are finicky toward habitat alterations because they so heavily depend on sagebrush. Fragmentation of habitat harms sage grouse if large openings (fragmented habitats) are created during mining. Braun (1998) found that openings larger than 150 to 200 meters would generally preclude use by sage grouse because they prefer to forage within 50 to 100 meters of escape cover. The environmental consequences of mining may be mitigated in part by mechanically treating alternative areas to provide suitable brood habitat on summer ranges.

Habitat fragmentation from mining includes the building of roads and structures. Roads directly and indirectly affect wildlife by doing the following (Young 1994):

- Impeding horizontal and vertical migration or dispersal.
- Subdividing populations that were previously connected.
- Increasing edge habitat.

Road placement and design are key elements to address for protecting and conserving wildlife. Braun (1999) reported that important sage grouse habitat has not been considered in establishing many roads (for mining and other uses) and that, therefore, roads commonly transect brood habitat, winter habitat, and migration corridors. Increased traffic may increase wildlife deaths. Roads also increase disturbance caused by human presence and activities, making highly visible wildlife species more vulnerable to harvest and harassment (Cole and others 1997; Stussy and others 1994).

Edge Effects. The creation of edge–the interface between adjoining plant community types–benefits some wildlife species. Many species are not adapted to edge habitats, and some are harmed. Road-edge habitats are hard-edged compared to natural edges, which tend to be soft-edged. Natural edges are less well defined, with vegetation types merging gradually from one community type to the other. But road edges tend to be abrupt, long-term, and more often disturbed. Road building increases air pollution, soil erosion, noise, direct vehicular fatalities, disturbance by human activities, and exotic species introductions. When combined, these factors create adverse habitat situations for many native species (Reed and others 1996).

Brown-headed cowbirds provide a good example of how one species may benefit and another be harmed by the creation of edge habitat. These birds are brood parasites that lay their eggs in the nests of host species. Cowbirds prefer edge habitats such as woodland edges (Lowther 1993). They have experienced a large expansion in range due to the creation of more edge habitats with road building and other habitat fragmenting. Cowbirds can seriously reduce the reproductive success of other species, particularly those with small populations (willow flycatcher, black-capped vireo, least Bell's vireo).

Predators that benefit from human activity (e.g. raccoons, coyotes, blue jays, crows, opossums, and feral cats) also tend to use edge habitats as foraging areas and often have a large adverse impact on bird populations (Robinson 1992; Robinson and others 1995; Robinson and others 2000).

Stress and other Disturbance Factors. Disturbance may physiologically and physically stress wildlife (Gabrielsen and Smith 1995). Ultimately, these responses may lead to increased mortality and decreased reproduction (Stephenson and others 1996). Two time periods are critical for many bird and mammal species: the immediate postnatal period in mammals and the breeding period in birds.

Noise. Mining inherently creates noise. Noise affects wildlife in a generally negative way (Shaw 1978). Signal detection would be reduced in areas in which human-generated noise is likely to interfere with acoustical signaling by wildlife (Shaw 1978). Disturbance may elicit physiological and physical responses in wildlife, as may the disturbance caused by noise (Gabrielsen and Smith 1995). But some wildlife species adapt to noise over time.

Potential impacts of disturbance to nesting raptors include the following (Fyfe and Olendorf 1976):

- Nest desertion.
- Damage to eggs or young caused by frightened adults.
- Overexposure of eggs or young to heat or cold.
- Missed feedings.
- Premature fledgling of young.

Call (1979) reported that frequent disturbance by mining can cause bald eagles to abandon their winter roosts or prevent them from using important feeding areas. The results of several raptor studies point to interspecific and intraspecific response differences, as well as differences by type of activity, season of year, and closeness to the disturbance (Bednarz 1984; Ramakka 1988; Holthuijzen and others 1990).

A variety of techniques have been employed to avoid or mitigate potential impacts to raptors (Ramakka 1988). Common recommendations include temporal restrictions of activities, selective road closures, or buffer zones around nests and roosts to prevent nest abandonment.

Bats are extremely vulnerable to disturbance. Entry to a winter bat roost during hibernation can trigger premature arousal and the depletion of fat reserves needed for winter survival. The disturbance of a maternity colony can cause mothers to abandon their young. The importance of such abandonment becomes apparent when considering that bats typically have one young per year. If an entire maternity colony is abandoned, the year's crop of young for that particular population would be lost (Brown and Berry 1991).

Mining on or next to water sources used by bats may impair the foraging abilities of bats. Bats use echolocation to find prey and maneuver. Mackey and Barclay (1989) examined the influence of physical clutter and noise on the activity of bats over water. Responses of bats varied by species, but the overall results suggested that both clutter and the increased background noise of running water reduce the activity of some bats by impeding the detection and capture of prey.

Responses of wild ungulates to disturbance, including the use of heavy equipment, vehicles, or human activities, may vary from subtle to extreme panic. Disturbance, therefore, may interfere with health, growth, and reproductive fitness of individual ungulates (Freddy and others 1986).

MacArthur and others (1982) examined cardiac and behavioral responses of mountain sheep to human disturbances (people afoot, people with dogs, different approach paths, road traffic, and air traffic) at the Sheep River Wildlife Sanctuary in southwest Alberta. A person approaching sheep with a leashed dog elicited the greatest response. Canids are the traditional predators of sheep, and it is not surprising that a dog would evoke an increased heart rate. Sheep also responded to the approach of humans from unexpected directions. Few reactions to road traffic were noted. MacArthur and others (1982) concluded that these mountain sheep were partially habituated to humans as a result of human visitation to the sanctuary but premised that sheep in less habituated populations would exhibit increased cardiac and behavioral responses.

Stephenson and others (1996) examined the response of mule deer movements to military activity. Mule deer increased their home range size in response to military training. Geist (1978) observed that animals in a largely predictable environment have a low reactivity to disturbances. Deer on the military site probably exhibited greater response to disturbance because training exercises were more random and unpredictable and tanks and other tactical vehicles were not restricted to roads.

Freddy and others (1986) found that mule deer were more disturbed by people on foot than by vehicles (snowmobiles). Responses to humans were longer and involved running more often, resulting in greater energy expenditure. As one would predict, mule deer response depended on the closeness of the disturbance to the deer.

Kuck and others (1985) examined the response of elk to simulated mine disturbance in Idaho. Elk calves subject to human disturbance and to simulated mine noises showed significant responses by altering habitat use and movement. Elk responded to levels of disturbance by interposing topographic barriers between themselves and the disturbance. The increased energy costs of movements, escape, and stress caused by these frequent and unpredictable disturbances may be detrimental to elk calves.

A serious consequence of persistent disturbance would be withdrawal of animals to marginal habitats where survival and productivity would be expected to diminish. Extrapolating from these studies, one could conclude that ungulates within the study area would be highly likely to respond similarly to mining. The mitigation measures discussed for habitat loss and fragmentation would help reduce the effects of mining-related disturbance.

Introduced Species. Introduced (nonnative or exotic) species evolved elsewhere and have been transported and purposefully or accidentally disseminated by humans. These species disrupt the functioning of native ecosystems. Most exotics become pests by rapidly dispersing into communities in which they have not evolved and by displacing native species (Li 1995). Many noxious weeds thrive in disturbed areas where they may out compete native vegetation and form monocultures of invasive species (Soulé 1990). When established, weeds may destroy thousands of acres of valuable wildlife habitat, making an area unsuitable for habitat-specific species.

Pollution. Cyanide is used in mining operations for the extraction of gold and silver from ores because of its strong tendency to form complexes with metals. Cyanide is a general respiratory poison, but uptake of cyanide can also occur through ingestion or exposure to the skin. Cyanide is a potent and rapid-acting asphyxiant. It can produce reactions within seconds and death within minutes. Cyanide acts rapidly in aquatic systems, but it does not persist for extended periods.

Cyanide is also highly species selective in its effects on organisms, including fish, birds, plants, and mammals. Cyanide inhibits ion transport mechanisms in amphibians. Wiemeyer and others (1986) found marked differences in toxicity of cyanide among species of birds. Study results found that species sensitivity to cyanide is not necessarily related to body size but to diet. Birds that feed predominantly on flesh were more sensitive to cyanide than species that feed on plants.

A variety of studies examined toxicity levels of cyanide on wildlife (Clark and Hothem 1991; Henny and others 1994). In one study of cyanide extraction in gold mines in three states (AZ, CA, NV), rodents and bats respectively accounted for 35% and 34% of total mortality. Ten mammal species that are endangered, threatened, rare, protected, or of special concern (lesser long-nosed bat, long-tongued bat, spotted bat, pika, Mojave ground squirrel, wolverine, California leaf-nosed bat, Townsend's big-eared bat, pocketed free-tailed bat, and badger) were documented mortalities (Clark and Hothem 1991).

Before the existing 3809 regulations were implemented, toxic concentrations of sodium cyanide, free cyanide, and metal cyanide complexes were readily accessible to a variety of wildlife. Wildlife died where cyanide solutions were open, such as in storage ponds, puddles on top of heaps, or flows in channels along the base of a heap to a pond. Most of the mortality was thought to be an acute response to ingestion of free or metal-bound cyanide. But inhalation and exposure to the skin were more important to aquatic species.

Since the 3809 regulations have been in effect, many studies have focused on the effects of heap leach solutions and mill tailing ponds on migratory birds. Birds are especially vulnerable during migration, when large populations are concentrated on limited habitat. This vulnerability was demonstrated in 1988, when 1,459 migratory birds were killed at a gold mine (FWS 1990).

Nevada reported that during the mid-1980s more than 9,500 birds, mammals, reptiles, and amphibians were found dead at mill tailings ponds and heap leach operations (Henny and others 1994b); 91% of the deaths consisted of birds, mainly waterfowl, shorebirds, and gulls. In 1989 Nevada passed a wildlife law that developed a program through its artificial pond permitting to require industry to report wildlife mortalities and protect these resources.

More recently, wildlife mortalities at mine sites in Nevada have decreased dramatically, from more than 2,000 individual animals in 986 to just over 300 in 1993 and 1997 (Molini 1998). To break these numbers down even further, less than 50% of these mortalities in 1997 were caused by contact with permitted facilities (cyanide ponds or the nets and fences that cover them). A nearly four fold decrease in the number of bird mortalities has been estimated for the 7-year period (Molini 1998).

Mine operators have begun to apply methods of protecting vertebrates from mine water poisoning by the following methods:

- Using netting and plastic sheeting.
- Applying dilution techniques to reduce cyanide concentrations.
- Making collection channels inaccessible to wildlife (Canter and others 1991; Henny and others 1994b).

A letter from the Nevada Division of Wildlife (Molini 1998) to "Interested Party" reported that wildlife mortality data show a substantial decline in all categories of animals except for a small increase in the number of waterfowl. The letter goes on to state, "Overall, wildlife mortalities associated with permitted facilities were down to the second lowest level recorded in the past ten years, 185 individuals." Although proven techniques exist for mitigating impacts to wildlife, some mines continue to use less effective techniques such as hazing, noise makers, and colored flagging (Clark and Hothem 1991).

Powerlines. Powerlines for mining may both benefit and harm wildlife. Powerlines may benefit raptor species by providing roost sites, nest sites, and prey surveillance. Conversely, these same powerlines may electrocute raptors or kill them when they crash into poles (Bevanger 1994; Faanes 1987). The following avian groups have been represented in counts of dead birds at powerline poles: waterfowl, gulls, cranes, shorebirds, rails and coots, cormorants, blackbirds, grebes, grouse, pelicans, raptors, doves, herons, woodpeckers, and other passerine birds. Although none of the mortality was considered to be biologically significant (Faanes 1987), the cumulative effects of mortality may be important to populations of rare or endangered species.

Bevanger (1994) reviewed published reports on powerlines. Storks, falcons, owls, and passerine birds were the most often reported victims of electrocution. Cranes, pelicans, storks, and grouse deaths were reported in excessive numbers from flying into these lines. Bevanger also points out that, although information is lacking to show that utility structures are a significant cause of death, powerlines are a serious cause of mortality for some listed species (whooping crane, peregrine falcon, Mexican spotted owl, northern spotted owl, brown pelican, wood stork). The above studies did not state whether these powerlines were for mining but are simply compilations of reported mortalities.

Netcher (1998) estimated that only about half of mines have powerlines. For mines with powerlines a variety of mitigation measures can be used to reduce electrocutions, including new power pole designs and modifications (Postovit and Postovit 1987). Three categories of modifications can mitigate powerline impacts:

- Designing and modifying poles, crossarms, and conductor placement to adequately separate energized parts.
- Insulating wires and other hardware where separation is impossible.
- Managing raptor perching.

Wildlife may be harmed by raptor use of utility structures for hunting. Sage grouse are heavily affected by raptor predation. Braun (1998) reported that sage grouse numbers and use increase as distance from the powerlines increase.

State Wildlife Protection Statutes

According to the Center for Wildlife Law and the Defenders of Wildlife (1998), state endangered species act provisions exist in 9 of the 11 study area states (see Appendix D). Utah and Wyoming are the exceptions, but they both have provisions for protecting wildlife. For the nine states with endangered species laws, all are dated between 1969 and 1976. California and New Mexico are the only states to require recovery plans. California and Oregon are the only states that require consultation for state-listed species. Despite the efforts of each state, few state acts provide effective programs for protecting threatened and endangered species.

Historically, states were given the role of protecting the wildlife within their borders. State governments have traditionally served as the stewards of wildlife. Today, they retain this responsibility, but the Federal Government has assumed primary responsibility for species protected by the Endangered Species Act (Center for Wildlife Law and the Defenders of Wildlife 1998).

Environmental Consequences

Impacts Common To All Alternatives

Direct Effects. Disturbances may benefit some species while harming others. Disturbance of habitat always causes short-term impacts and may cause long-term impacts, depending on the following:

- Length of time before reclamation prescriptions are applied to a site.
- Length of time for vegetation to become established.
- The suitability of vegetation to fulfill species-specific habitat requirements.

Indirect Effects. Indirect impacts of mineral activities would generally be those that do not occur immediately. Indirect effects can occur to the area directly affected by the mineral activity or to an adjacent area. Such effects could include loss of habitat or degraded habitat condition for proposed or listed species from the long time frames required for site reclamation.

Public access to mined areas is expected to increase because of the attraction created by mining and the building of new roads.

A significant percentage of the unimproved and sometimes improved roads on public lands have resulted from the direct and indirect effects of mining since the passage of the Mining Law. Thus, route proliferation and habitat fragmentation become issues when they affect proposed and listed species and proposed and designated critical habitats. Increased vehicular access might result in new and sustained impacts to ecosystems that support proposed and listed species. In some cases, the disturbance to proposed and listed species might be greater than during mining because of the diversity of activities allowed by access (exploring, shooting, hunting, collecting, camping).

Through the land use planning process, BLM will address vehicle use management and designate lands as open, limited, and closed to off-road vehicle (ORV) use. Another category–undesignated–allows for unlimited vehicle use pending a final decision. Most of the public lands are in an open or undesignated category for ORV use. These designations are expected to change through land use planning decisions and a new effort by BLM to manage ORV use to protect natural and cultural resources. Threatened or endangered species issues caused by ORVs during casual use are directly related to the adequacy of decisions under the ORV regulations (43 CFR 8340) rather than to the surface management regulations (43 CFR 3809).

Alternative 1: No Action

Notice-level activities would continue under the existing regulations. Because they do not constitute federal actions, such activities do not require Section 7 consultation under the Endangered Species Act (ESA). Section 7 requires federal agencies to ensure that their actions (including permitting) are not likely to jeopardize the existence of a listed species (plant or animal) or destroy or modify critical habitat. Without consultation, it is difficult to prevent or mitigate harm to threatened and endangered species. Therefore, No Action presents a potential for the taking of threatened or endangered species.

Financial guarantees are not required for Notice-level operations under the existing regulations, and some operators might abandon their operations without reclaiming them. Since 1981, failure to reclaim has accounted for about 67% of all notices of noncompliance. Where sites are not properly reclaimed or not reclaimed in a timely manner, wildlife habitat would continue to be lost, fragmented, or otherwise degraded.

Casual use is not subject to agency notification. Without notification, BLM cannot determine if the casual use might harm threatened or endangered species. Even though casual use involves minimal surface disturbance, cumulative disturbance has caused harm. In one case digging for dry placers by a recreational mining club left open holes large enough to trap desert tortoises. Harm might even result from a single incident of casual use such as digging with hand tools where an endangered species is confined to a single location at a unique seep or spring.

Alternative 2: State Management

Regulations would vary by state under Alternative 2. Without a set of comprehensive federal regulations, the overall protection and restoration of wildlife and habitat would decrease. Alaska, Arizona, and Nevada do not require permits for operations disturbing less than 5 acres. Idaho requires documentation of activities for exploration involving less than 5 acres, but not until after the activity has ended. Without notification, it would be difficult for state agencies to protect wildlife and their habitats and enforce reclamation.

Under Alternative 2 weed control would depend on state and local efforts. The lack of a comprehensive policy would likely increase the potential for infestations. An increase in the spread of weeds would harm biodiversity, habitat quality, and ecosystem functions, and have the potential to decrease native wildlife populations.

Mineral operations under Alternative 2 would no longer consist of federal and would not be subject to consultation under Section 7 of the Endangered Species Act (ESA). Section 7 requires federal agencies to ensure that their actions (including permitting) are not likely to jeopardize the existence of listed plant or animal species or destroy or modify critical habitat. Without consultation, it would be much more difficult to prevent or mitigate harm to threatened and endangered species than under the existing regulations. Therefore, Alternative 2 would increase the likelihood of the taking of species.

Alternative 3: Proposed Action

The strengthened performance standards in Alternative 3 for vegetation, soils, wildlife, and riparian-wetland resources would result in better wildlife protection and habitat restoration and help maintain wildlife populations at present levels.

Under the proposed regulations, all mining and milling projects would require Plans of Operations, resulting in a more formal review and approval of activities. This added planning should promote better restoration of wildlife habitat than the existing regulations. In addition, all mining and milling would be federal actions and subject to consultation under Section 7 of the Endangered Species Act. The likelihood of operations taking endangered or threatened species would decrease.

Under Alternative 3, BLM would have more discretion in determining the types of impacts operators could cause. BLM could prohibit operations that would cause substantial irreparable and unmitigatable harm to significant resources. Given this discretion, Alternative 3 would help maintain population levels of threatened and endangered wildlife species at their current levels.

BLM could establish areas where operators must contact BLM before beginning their operations. BLM would then determine whether Notices or Plans are required. The provision was designed to protect wildlife, especially, threatened and endangered species, from the cumulative impacts of casual use's causing more than negligible disturbance. The required notification would better protect wildlife from unnecessary and undue degradation and help maintain population levels of threatened and endangered species at their current levels.

The Proposed Action would require reclamation bonds for all Notice-level operations. This financial assurance should prompt better compliance by operators than would the existing regulations in reclaiming and restoring wildlife habitat. Moreover, should the operator default, BLM would have funds to reclaim and restore wildlife habitat.

Under Alternative 3, inspections and monitoring of operations would become mandatory four times annually where cyanide is used or where acid rock drainage is occurring or might occur. Such monitoring and inspection would alert managers to potential wildlife hazards and decrease wildlife deaths from what would result under the existing regulations.

Alternative 4: Maximum Protection

Alternative 4 would require that vegetation on reclaimed areas be long lasting, self-sustaining, and comparable in diversity and density to the preexisting natural vegetation, and achieve 90% of the canopy cover of adjacent, undisturbed lands. Alternative 4 would also require that only native plants be used for revegetation. Riparian areas would also have to be restored to proper functioning condition within 10 years. These requirements would help restore wildlife habitat to conditions similar to or better than the preexisting plant community and would help increase the likelihood of maintaining population levels of wildlife species at their current levels.

Alternative 4 would eliminate Notices, and all projects causing more than negligible disturbance would require Plans of Operations. This change would result in a more formal review and approval of activities. The added planning should promote better wildlife habitat restoration than would the existing regulations. In addition, all projects beyond casual use would be federal actions and subject to consultation under Section 7 of the Endangered Species Act, resulting in a decrease in the likelihood of the taking of endangered or threatened species.

Under Alternative 4, operators could not jeopardize special status species and cause them to be listed as threatened or endangered.

Alternative 5: NRC Recommendations

Under Alternative 5, all mining and milling would require Plans of Operations, resulting in a more formal review and approval of mineral activities. This added planning should promote better restoration of wildlife habitat than would the existing regulations. In addition, all mining and milling would therefore be considered federal actions and subject to consultation under Section 7 of the Endangered Species Act. The result would be a decrease in the likelihood of the taking of endangered or threatened species.

Alternative 5 would require reclamation bonds for all Notices. This financial assurance should prompt better compliance by operators than would the existing regulations in reclaiming and restoring wildlife habitat. Moreover, should operators default, BLM would have funds to reclaim and restore wildlife habitat.

Cumulative and Residual Impacts to Wildlife Resources

In the first 17 years after the 3809 regulations went into effect in 1981, exploration and mining disturbed an estimated 214,000 acres of public lands. Projections for mineral activities over the next 20 years show that mineral operations under the existing regulations and alternatives would disturb as much as 183,000 more acres. The total surface disturbance on vegetation from past and reasonably foreseeable mineral activities over the final EIS period, therefore, would equal as much as 400,000 acres. This amount represents about 0.12% of the total acreage of public lands and Stock Raising Homestead Act lands administered by BLM within the study area (see Table 3-1). The cumulative impacts from mining and exploration on wildlife within the study area would therefore be limited.

Residual impacts on wildlife habitat would affect the 400,000 acres directly disturbed by mineral activities. As discussed in the vegetation and soil sections, mining usually changes the original soil profile, which ordinarily requires hundreds to tens of thousands of years to develop. Mining might therefore yield soil substrates that greatly differ from what was there before mining.

These differing substrates might affect the rate of succession or completely alter it. Different trajectories of succession are therefore possible, and this altered succession represents a loss of wildlife habitat that existed on the site before mining. Alternative 4 would require more of the soil profile to be salvaged than would the other alternatives, resulting in a better chance of establishing similar substrates able to support vegetation and wildlife habitat similar to what existed on a site before mining.

WILD HORSES AND BURROS

Affected Environment

The Wild Free-Roaming Horse and Burro Act of 1971 requires wild horses and burros to be managed at proper management levels and prohibits their relocation to areas where they had not lived before 1971. One of the act's goals is to manage populations to create a thriving natural ecological balance on public lands. Proper management levels have not been set for all herd management areas but are estimated to be 23,500 wild horses and 3,600 wild burros.

In October 1997 about 37,600 wild horses and 5,400 wild burros inhabited some 200 herd management areas (HMAs) on federal land in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Wyoming. BLM manages HMAs whose populations exceed proper management levels to reduce populations by selective removals, including adoptions, fertility control, and natural mortality.

Normally, wild horses almost exclusively eat grasses. Burros have a more diverse diet of grasses, forbs, and shrubs. Wild horses and burros graze throughout their HMAs, including upland and riparian areas. Both wild horses and burros migrate short distances during seasonal movements.

The most critical time of year is in the spring during foaling. The social dynamics of wild horse herds, such as competition between stallions, causes dispersion. Wild burros tend to disperse as water becomes plentiful.

Environmental Consequences

Impacts Common to All Alternatives

Mines operating within herd management areas (HMAs) might harm wild horses and burros. Exploration and mining might reduce forage and restrict access to some water sources. Mine dewatering might also reduce water supplies. Increases in noise and vehicular traffic and the presence of humans in these areas might force herds to move to other areas. Horse and burro sensitivity to such activity would be most acute during spring foaling. Animal and human safety are also concerns, mainly along access roads that cross HMAs.

Alternative 1: No Action

Herds could be displaced by noise, vehicle traffic, human presence, or loss of forage or water sources. Water sources could be lost by restricted access or dewatering. Sensitivity would be most acute during spring foaling.

Alternative 2: State Management

Impacts under State Management would be the same as under the existing regulations.

Alternative 3: Proposed Action

Under Alternative 3 mining would have to comply with provisions of approved BLM land use plans, providing that compliance does not impair claimant rights under the Mining Law. In the foreseeable future, provisions could be added to land use plans to limit the amount, type, or timing of mining in HMAs. Affected wild horse and burro populations would benefit from limiting use of heavy equipment, drilling, blasting, and truck traffic within HMAs.

Alternative 4: Maximum Protection

Under Alternative 4 mining would have to comply with provisions of approved BLM land use plans. In the foreseeable future, provisions could be added to land use plans to limit the amount, type, or timing of mining in HMAs. Affected wild horse and burro populations would benefit from limiting use of heavy equipment, drilling, blasting, and truck traffic within HMAs

Alternative 5: NRC Recommendations

Under Alternative 5 mining would affect wild horses and burros much as would Alternative 1 but would have to comply with approved land use plans. Range resources would have more protection than under the Alternative 1 through the requirement of comprehensive Plans of Operations for all mineral activities except exploration and casual use.

LIVESTOCK GRAZING

Affected Environment

Livestock grazing is one of the major land uses within the study area. BLM administers livestock grazing on federal lands under the authority of the Taylor Grazing Act. Other laws that govern livestock grazing on federal lands include the Bankhead-Jones Farm Tenant Act, National Environmental Policy Act, Federal Land Policy and Management Act, and Public Rangelands Improvement Act. BLM authorizes more than 9.4 million animal unit months (AUMs) of livestock forage on public lands in the study area (excluding Alaska) on 21,600 allotments covering nearly 161 million acres.

Since 1981, mineral activities on public lands have disturbed about 214,000 acres in the study area. Although we do not know how many AUMs of forage have been lost due to mining since 1981, an estimated 10,000 AUMs (0.1% of current AUMs authorized) have been irretrievably lost to mining on the basis of the following assumptions:

- Livestock consume 1 AUM for every 20 acres (161 million acres in allotments divided by 9.4 million AUMs).
- Livestock graze all acres in allotments.
- Livestock grazed all acres previously disturbed by mining.

These are restrictive assumptions that greatly overstate the likely actual impact because livestock do not graze all acres in allotments, livestock did not graze all acres previously disturbed by mining, and not all disturbance where grazing does occur results in a loss of AUMs. Nevertheless, this estimate gives a perspective on the general size of the impact.

Environmental Consequences

Much of the information in the following discussion was derived from the Stone Cabin Mine Final EIS (BLM 1994c). The impacts discussed would be common to all alternatives.

Impacts on livestock grazing from any of the alternatives could result from the following:

- Direct and indirect displacement of grazing.
- Conflicts with traffic.
- Blockage of livestock access.

These impacts would not generally be attributable to a single mine component but might result from the aggregate of all mine components and related activities.

Removal of vegetation during mine construction and operations would directly replace livestock grazing. In addition, a larger area would be affected where mine features are fenced. When mining operations are developed where livestock graze public land, BLM must sometimes reduce permitted use. Under these circumstances, grazing permits and leases are permanently adjusted, as provided for in the grazing management regulations. Generally, these reductions are not restored following reclamation of mining sites.

Mine developments would also directly or indirectly displace rangeland improvements. Fences separating grazing allotments and pastures might be disrupted. Fences would have to be realigned. Or new fences, cattle guards, or other devices would be installed to maintain the integrity of allotments, pastures, and ownership during all phases of mining. Without these steps, cattle from different allotments and pastures would mix. In addition, important livestock watering ponds, springs, and devices might also be degraded.

Airborne dust would likely reduce vegetation productivity and palatability downwind of and immediately next to mines and travel routes. But most dust generated would settle within fenced areas, reducing impacts on livestock.

Cattle displaced from mine developments would tend to concentrate in other preferred areas, most likely near water sources, including wetland and riparian areas.

Mine traffic is expected to increase, resulting in possible livestock losses and damage to vehicles.

Long-term impacts to grazing include direct displacement by unreclaimed or unsuccessfully reclaimed areas. Additionally, reclaimed acres could not be grazed for several growing seasons until grasses and forbs become established. In some areas grazing would never resume because permanent changes in topography could not accommodate livestock. Reestablishing grazing too quickly in these areas would endanger the success of revegetation by overgrazing susceptible young plants.

Until vegetation becomes established, these areas would provide only a fraction of the carrying capacity of similar undisturbed areas. Grazing would be further delayed on a portion of the revegetated areas because to become successful, some revegetation would probably need reseeding.

Fences and other range improvements would be restored to as close to premining conditions as practicable. Fences around mine features would be removed at some point after reclamation.

With closure and reclamation, all mining would cease. Therefore, some grazing might be restored, but, depending on the type of mining, grazing would not be restored to previous levels. Therefore, some forage losses would be irreversible.

For the most part, access through mined areas would be improved by the presence of mine roads that are not reclaimed. This improved access would increase recreational travel through mined areas. Some of the other access roads blocked by mines would also be reopened. New traffic would increase the probability of conflicts between livestock and people engaging in recreation. The effects of such conflicts cannot be reliably predicted.

SPECIAL STATUS AREAS

Affected Environment

Special status areas are lands that BLM has determined have resources of unique or distinct value. These lands have a variety of designations, depending on the authority under which they were designated and the resources present. Some special status areas are open to mineral activity under the Mining Law or, if closed, contain mining claims that may have prior rights for mineral development.

Special status areas where exploration and mining are subject to the 3809 regulations include the following:

- Areas of critical environmental concern (ACECs).
- Lands in the California Desert Conservation Area (CDCA) designated as controlled or limited use areas.
- Areas in or designated for potential addition to the National Wild and Scenic Rivers System.
- Areas closed to off-road vehicle use.
- Designated wilderness areas.

Resources that contribute to the designation of these areas are diverse. Special status areas may be designated to protect a wide variety of resources, such as sensitive plants, wilderness characteristics, scenic vistas, geothermal features, or American Indian sacred sites. Special status areas may also be designated because of potential hazards such as abandoned mines or hazardous materials. The potentially affected resources in special status areas are some of the most valuable and significant resources found on BLM-managed lands. A comprehensive description of all resources in BLM special status areas would be exhaustive.

As of September 30, 1999, a total of 740 designated areas of critical environmental concern (ACECs) covered about 13.1 million acres of public land managed by BLM (BLM 2000a). Some of these ACECs are closed to activity under the Mining Law, or are closed but contain mining claims with prior mineral development rights. Other ACECs have been left open to the operation of the mining laws with the 3809 regulations used to manage mineral activity in concert with the ACEC resources.

There are 34 BLM-administered rivers in the National Wild and Scenic Rivers System with more than 2,000 river miles and 998,468 acres under protection (BLM 2000a). Some lands in the system are open for operations under the mining laws or have prior development rights that are subject to the 3809 regulations.

BLM manages 5,243,332 acres of wilderness in the United States (BLM 2000a). These areas are all closed to activity under the Mining Law, but some areas have mining claims with prior development rights under the mining laws. Mining activities in wilderness areas with prior development rights under the mining laws would be regulated by the 3809 regulations.

Environmental Consequences

Impacts to special status areas would depend on the impact to the particular resource that led to the area's nomination or designation. This discussion considers changes in the definition of what the regulations consider a special status area and standards the 3809 regulations provide for the resources within special status areas.

Alternative 1: No Action

The existing regulations require operations in the California Desert Conservation Area, in wilderness areas, and along wild and scenic rivers to meet the statutory level of protection or reclamation required by the establishing act. Impacts from operations in these areas can and have been conditioned to meet these requirements. This provision would continue to prevent impacts to resources in these areas as required by the areas' establishing authority. This provision would also preserve the resources that supported the areas' special status designation.

The existing regulations do not require a higher standard for resource protection in areas of critical environmental concern (ACECs) or areas closed to off-road vehicles (ORVs). Any mineral activity greater than casual use would continue to require an approved Plan of Operations. The Plan review and approval process would allow mitigation to be designed to protect resources in the special status area. But the performance standard is still based on the requirement to prevent unnecessary or undue degradation. There is no higher standard for environmental protection in these areas similar to areas designated by statute.

In the past this lack of higher standards has occasionally resulted in impacts to the resources that supported designation of the ACEC or ORV closure. These potential resource conflicts would continue to occur on a site-specific basis. In extreme cases the resources that resulted in ACEC designation could be significantly affected.

Alternative 2: State Management

The levels of protection or reclamation required by statute would continue to apply to some special status lands. State regulatory agencies would administer these requirements, but enforcing these requirements without BLM review and approval of individual Plans might result in some projects not meeting statutory requirements for resource protection.

Impacts to resources in ACECs or areas closed to ORV use would depend on the efficiency of the state regulatory programs and be highly site specific. Land use or activity plans would guide the states on special values of concern. But without BLM review and approval, the potential is likely to increase for mineral activities to harm resources in these special status areas.

Alternative 3: Proposed Action

The proposed regulations would continue to give the same level of resource protection to special status areas as designated by statute. Expanding the list of special status areas to include certain threatened or endangered wildlife habitat, national monuments, and national conservation areas would improve protection of sensitive resources. By requiring a Plan of Operations for activity that previously could occur under a Notice, the Proposed Action would add review times and analysis requirements that would likely improve protection of these resources.

The proposed performance standards would provide a tie to land use plans. This tie would result in specific consideration of the resources in special status areas and is likely to more effectively mitigate potential impacts to these resources.

The proposed regulations would reduce the potential for environmental impacts to resources in special status areas because of the following:

- More stringent performance standards (including the new definition of unnecessary or undue degradation).
- Plan review requirements.
- Predicted decrease in mineral activity.

But the potential remains for these areas to be affected if they are open to mineral activity. Should the proposed mineral activity be determined to constitute substantial irreparable and unmitigatable harm to significant resources, then BLM would deny the Plan of Operations. Such action is most likely to occur in special status areas because these areas were usually designated because of their significant or sensitive resources. The requirement to prevent substantial irreparable harm would give a high level of protection to resources in special status areas. Therefore, mineral development would not jeopardize the resources that led to the special status area designation.

Alternative 4: Maximum Protection

Alternative 4 would protect resources in special status areas designated by statute. Mandatory conformance with land use plans would prevent impacts to these areas. Land use plans would provide prescriptions to ensure that the resources that led to the special status area designation are not affected. In addition, the requirements to prevent irreparable harm to resources would allow BLM to preclude activities that would affect special status areas and their resources. Alternative 4 would give a slightly higher level of protection for special status areas than would the Proposed Action.

Alternative 5: NRC Recommendations

Alternative 5 would not expand the list of special status areas but would require a Plan of Operations for all mining. Certain areas that would have been special status areas under the Proposed Action, such as valuable wildlife habitat, national monuments, and national conservation areas, would still receive increased protection from mining through the Plan of Operations review process, but not from a change in performance standards. Exploration creating less than 5 acres of disturbance could still occur in these areas under Notices. But this provision is not likely to have a significant impact because of exploration's more limited disturbance size, duration, and reclaimability when compared to mining. In addition, the provision to bond Notice-level operations would assure reclamation of disturbance in these areas.

The existing performance standards and continued use of the existing definition of unnecessary or undue degradation under Alternative 5 would not preclude mining from significantly affecting some special status areas that are not protected by other legal authorities. Though such occurrences would be rare, if due or necessary for mine development, disturbance could significantly degrade the resources for which some special status areas were designated.

RECREATION

Affected Environment

BLM manages public lands for a variety of recreation uses, including hunting, fishing, rock collecting, camping, sightseeing, hiking, winter sports, and off-road vehicle (ORV) use. Most recreation use depends on the natural and cultural features of the land. Public lands in the study area are renowned for their diverse scenic and visual resources. Generally good air quality and dramatic topography combine to create spectacular vistas. The popularity of scenic and backcountry byways and scenic overlooks illustrates the value and appreciation of scenic quality.

Federal lands have a growing number and diversity of visitors seeking recreation (Cordell and others 1989). On BLM-administered lands during 1996, recorded recreation use exceeded 72 million visitor days. Projections show that these numbers will continue to grow, particularly for camping, sightseeing, hiking, ORV use, and winter sports (Environmental Resources Assessment Group 1997).

At the same time, access to federal lands is an increasing problem in many western states, particularly where private lands must be crossed to reach federal lands. Access is being lost where ranches are bought for recreation and recreation homesites; ranchers lease their land to outfitters and close it to others; or ranchers are attempting to avoid vandalism, litter, or open gates.

Maintenance of recreational resources on federal land is important for “quality-of-life” issues. Research on the effects of participation in outdoor recreation show such benefits as improved physical and mental health, increased self-esteem, an enhanced sense of well-being, and spiritual growth. Participation in outdoor activities can also increase family interaction and foster cohesion. Benefits to communities include increased social solidarity, satisfaction with community life, and increased ethnic and cultural understanding (Cordell and others 1989). The same report also cites some of the major issues facing recreation today:

- Protecting resources and open space.
- Acquiring more land and water to meet expected demand.
- Resolving conflicts among diverse users.
- Addressing the need for more access to outdoor recreation areas.

An inventory of an area’s wildland recreational settings based on its physical, social, and managerial attributes is the basis for the recreational opportunity spectrum (ROS). These attributes combine to produce recreation opportunities that have three components: an activity, a resource setting, and an experiential component. By combinations of these attributes, lands can be characterized by a continuum of recreational opportunity classes, including primitive, semiprimitive nonmotorized, semiprimitive motorized, roaded natural, rural, and urban.

Primitive settings have essentially unmodified natural environments. Their size and configuration assure remoteness from the sights and sounds of human activity. The use of motorized vehicles and equipment is not permitted in primitive settings except in extreme emergencies. Moreover, the user is forced to be self-reliant and expects to see few people.

At the opposite end of the continuum, urban settings have high levels of human activity and concentrated development, including developments for recreation opportunities. Urban settings also have a preponderance of signs and other indications of regulations on user behavior.

The opportunity classes serve as an inventory tool for current recreation conditions and visitor expectations. Because mineral development could lead to changes in these settings, opportunity classes serve as a useful measure to help describe the consequences of such development. (USFS 1990; Montana Dept. of State Lands and others 1992). Although most of the public lands have not been inventoried using the ROS system, the opportunities on public lands tend to fall toward the more primitive end of the spectrum (including primitive, semiprimitive nonmotorized, semiprimitive motorized, and roaded natural).

The effects of mining on recreation tend to be localized and depend on a variety of factors, including the size and type of mine, the mine's setting, the recreation activities occurring in the area, the experience derived from these activities, and opportunities for similar activities in other nearby areas. The following are examples of the types of effects that locatable mineral activities could have on recreation:

- Loss of recreational resources that might lead to displacement of the activity to alternative areas or loss of the ability to engage in the activity.

- Modification of recreation settings leading to changes in recreation experiences due to project-related activities or the presence of project-related facilities.

- Reduced feelings of solitude and remoteness due to the introduction of visual, sound, or other sensory effects from project-related activities that could conflict with recreation use.

- Changed access to the area, which could open the area to some uses and close it to others. For example, mine developments can reduce opportunities for nonmotorized recreation while increasing opportunities for motorized recreation.

- More local recreation by the local population that mine employment has increased.

- Potential effects to the regional ecosystem's health that could decrease opportunities to use these resources for recreation (BLM and USFS 1997).

Effects of mining on recreation can vary a great deal. The following examples outline potential effects to recreation from different types of mines under the existing regulations. More than 125,000 acres of public lands (of the study area's 262 million acres of public lands) are estimated to be currently disturbed by locatable minerals mining.

Impacts have the potential to be most severe when a large open pit mine is located in an area of high-quality, irreplaceable recreation. An example potentially severe impacts may be seen in the proposed New World Mine, which would have been located northeast of Yellowstone National Park and could have affected the prime recreation experiences in and near the park (BLM and US FS 1997). This mine will not be developed (this project was not on BLM-managed lands). But had the mine been developed, effects could have included the following:

- Changes to the recreation setting, including eliminating recreation at some sites and changing other settings by direct visibility of mining, which would eliminate feelings of remoteness and isolation.

- Changes in access, including new roads, increased traffic management, increased congestion, and blocked traffic.

- Changes in the sensory experience of backcountry users and others who are seeking a natural experience, including more noise, perception of increased congestion and crowding from mining-related traffic, and artificial night lighting.

- Effects to hunting and fishing where mining might alter wildlife patterns or fishing opportunities.

The following examples outline potential effects to recreation from a large open pit mine, a placer mine, and a bentonite strip mine under the existing regulations. These examples represent the types of impacts from mining on BLM lands.

The Bootstrap Project is an open pit mine in the Carlin Trend area near Elko, Nevada (BLM 1996c; Treiman 1998). Lands in the region provide diverse recreational activities, including fishing, sightseeing, hunting, cross-country skiing, white water rafting, photography, rock collecting, and off-road vehicle use. The Bootstrap Project is increasing the amount of land disturbed by mining and has resulted in less land for recreation. In addition, because much of the area next to the mine is being used for exploration, public access there has been restricted for safety and security reasons.

The Bootstrap Project area, however, is not intensively used for recreation and does not offer unique recreational opportunities. The region contains large areas of similar land open to the public for dispersed recreation. It is assumed that people can go elsewhere for a similar recreation experience outside the project area.

Recreation potential unrelated to mining is also changing in the region. Many land owners who allowed unrestricted access in the past have reacted to increased use and abuse by locking gates on their private lands, thereby restricting access to public lands. Some of the increased use may be the result of users displaced from areas affected by mineral exploration and mining. These losses could make it more difficult to replace the recreation activities lost to mining.

The Birch Creek Placer Mining Final Cumulative EIS (BLM 1988a, McClain 1998) discusses the potential impacts to recreation from placer mining in the Birch Creek watershed about 70 miles northeast of Fairbanks, Alaska. Birch Creek, a national wild river, is managed as a part of the Steese National Conservation Area. The national wild river offers outstanding recreational opportunities for floatboating for the experienced canoeist and is one of the few clearwater rivers in the state with road access at two points on an otherwise undisturbed river. In addition to floatboating, visitors to the area fish, hunt, study nature, observe wildlife, wilderness camp, and hike.

Placer mining has affected recreation in this area in a variety of ways. New mining roads have allowed access to new areas for off-road vehicle (ORV) use, with some trespass occurring in areas closed to ORVs. Boating and hunting have increased substantially in the past 15 years due mainly to better access. This increased use has reduced the quality of the primitive recreation experience. Degraded water from holding pond breeches and mining claims in the headwaters of Birch Creek during high water events have degraded the recreational experience of float boaters downstream. The water quality during regular and low flows has steadily improved over the past few years, but some mining practices still result in periods of degraded water in medium to low water flows.

The Cody Resource Management Plan/EIS (BLM 1988c; Bye-Jech 1998) addressed the effects of bentonite strip mining on recreation in northwest Wyoming. Before mining, the areas with potential for bentonite development offered limited recreation, including ORV use and some hunting. Bentonite mining has opened some areas that were previously inaccessible, decreasing opportunities for nonmotorized activities and increasing opportunities for motorized activities, including ORV use. These newly accessible areas have replaced hunting or ORV opportunities that were lost or reduced through mining.

Recreational Mining

Recreational mining includes a variety of activities such as gold panning, using backpack suction dredges and sluice boxes, rock collecting, and other nonmechanized activities. Recreational mining occurs to some degree in most of the western states but is difficult to define because it is based on the motivation of the participant rather than a specific activity. Recreational mining takes many different forms, including with a group or alone, with or without a mining claim or in BLM-designated areas, and as an occasional activity or a much more frequent one. Because BLM has considered much recreational mining casual use and no contact with BLM was required, the number of people engaging in recreational mining on public lands is not known.

Currently this activity is handled in different ways in BLM field offices. In some areas a recreation permit (not a 3809 authorization) is required to use an area that BLM has specifically developed for recreational use. An example is in northern California where people can rent a site for dredging and sluicing for up to 30 days. For this area BLM issues about 90 permits annually. In the Medford Field Office area (Oregon) four areas are open to dredging, panning, and sluicing, and BLM requires a free recreation permit is required.

In other areas mining clubs are active and own claims where their members can engage in mining for a fee. In the California Desert, mining clubs stake mining claims and stage mining events. These events might draw several hundred people, many of whom engage in dry wash placer mining. Mining club principals submit Plans of Operations. In these cases, each person might be engaging in casual use, but the cumulative effects of all the participants cause more than negligible surface disturbance.

In other cases no permits are required even though many people might use an area. At Topaz Mountain, Utah, people come from around the world to collect topaz using hand tools. No permit is required, and the number of collectors is not known.

Some tourists are also interested in visiting old mining camps or towns and seeing and participating in mining activities. Examples of such places include Nome, Alaska; Virginia City, Nevada; and Virginia City, Montana.

Environmental Consequences

Alternative 1: No Action

Under No Action mineral operations could continue to affect recreation user experiences as they have in the past. Examples of the types of impacts from current management are included in the discussion above. These effects would vary a great deal depending on the following:

- Resource setting.
- Current recreation use of the area.
- Size and type of mine.
- Opportunities for using alternative areas.

Overall, the mix of recreational opportunities could change in localized areas. Opportunities at the primitive end of the spectrum could decrease, while opportunities for more developed recreation could increase. Areas that offer experiences at the more primitive end of the recreation opportunity spectrum would be more vulnerable because mining tends to dominate local settings, potentially eliminating their wildland character. Recreationists who prefer a primitive setting could be faced with a choice of diminished experience, finding an alternative area in which to recreate, or giving up the activity. Mine development, however, could increase the opportunities for some types of recreation by building roads into previously inaccessible areas.

Effects to wildlife and streams would continue under this Alternative and could reduce hunting and fishing opportunities.

Opportunities for recreational mining would continue as they have in the past.

Alternative 2: State Management

Effects under the State Management Alternative could be similar to those under No Action. But the potential for mining-related effects to resources–including water quality, wildlife, and more primitive recreation settings–would slightly increase, generally due to the increased level of mineral activity.

Overall, the mix of recreational opportunities could change in localized areas. Opportunities at the primitive end of the spectrum could decrease, and opportunities for more developed recreation could increase. Areas that offer experiences at the more primitive end of the recreation opportunity spectrum (ROS) would be more vulnerable because mining tends to dominate local settings, potentially eliminating their wildland character.

Mine development, however, could increase the opportunities for some types of recreation by building roads into previously inaccessible areas. Effects to wildlife and streams would continue under Alternative 2 and could reduce hunting and fishing opportunities.

Opportunities for recreational mining could continue as they have in the past.

Alternative 3: Proposed Action

Effects under the Proposed Action would be similar to those for the No Action Alternative. Overall, the mix of recreational opportunities could change in localized areas. Opportunities at the primitive end of the spectrum could decrease, and opportunities for more developed recreation could increase. Areas that offer experiences at the more primitive end of the recreation opportunity spectrum would be more vulnerable to mining because mining tends to dominate local settings, potentially eliminating their wildland character. Mine development, however, could increase opportunities for some types of recreation by building roads into previously inaccessible areas. The magnitude of the above changes would be much less than under No Action.

The potential for mining-related effects to resources, including water quality, wildlife, and more primitive recreation settings, would be much less than under No Action. This reduction would help maintain existing recreation uses related to fishing and hunting. In addition, visual resources would be much better protected than under No Action.

Recreational mining that meets the casual use criteria (such as gold panning, metal detecting, rock collecting, hand and battery drywashers) would continue as before. A Notice or Plan, including bonding for reclamation, would be required if an activity were to exceed the casual use threshold. Suction dredging would be allowed without a Notice or Plan if a state permit is required and BLM and the state have signed an agreement. But none of these agreements are in place, and it is unclear how they would function because each would depend on local management decisions.

If BLM and the state do not have an agreement, the operator must contact BLM to see if the action exceeds casual use. In those cases the operator would have to file a Notice or Plan with bonding, and that process might delay or preclude some activity. Casual use mining would decline by an estimated 10% to 25%, with the decline in activity disproportionately falling on suction dredge users. Once participants become familiar with the new rules, however, the effect could decrease.

Alternative 4: Maximum Protection

Effects on recreation under Alternative 4 would be similar to those under No Action. Opportunities at the primitive end of the spectrum could decrease, while opportunities for more developed recreation could increase in localized areas. Areas that offer experiences at the more primitive end of the recreational opportunity spectrum would be more vulnerable to mining development because mining tends to dominate local settings, potentially eliminating their wildland character. Under Alternative 4, however, large open pit mines, which have the greatest potential to affect recreation, would decline more than any other type of activity. The magnitude of the changes in the mix of recreational opportunities would be much less than for No Action or the Proposed Action.

To the degree that mining would decline (up to 65% from the current situation, depending on the type of mining), Alternative 4 would allow more opportunities for recreation than would any of the other alternatives. But Alternative 4 would forgo recreation opportunities created by mine roads providing access into previously inaccessible areas.

Under Alternative 4 all participants in mining activities would have to contact BLM to determine if their planned activity is casual use or if a Notice or Plan (including bonding for reclamation) is required. Requiring all participants to consult with BLM and some to file Notices or Plans might delay or preclude some recreational mining. Casual use mining would decline by an estimated 30% to 50%. The decline in activity would disproportionately fall on suction dredge users. Once participants become familiar with the new rules, however, the effect could decrease.

Alternative 5: NRC Recommendations

Effects under Alternative 5 would be similar to those under No Action. Overall, the mix of recreational opportunities could change in localized areas. Opportunities at the primitive end of the opportunity spectrum could decrease. Opportunities for more developed recreation could increase. Areas that offer experiences at the more primitive end of the recreation opportunity spectrum would be more vulnerable to mining because mining tends to dominate local settings, potentially eliminating their wildland character. Mine development, however, could increase opportunities for some types of recreation by building roads into previously inaccessible areas. The magnitude of the above changes would be slightly less that under No Action.

The potential for mining-related effects to resources, including water quality, wildlife, and more primitive recreation settings, would be slightly less than under No Action. This reduction could help maintain existing recreation uses related to hunting and fishing.

The definition of causal use would remain the same under this Alternative 5, so recreational mining that meets the criteria for casual use would continue as before.

VISUAL RESOURCES

Affected Environment

Public lands in the study area are renowned for their diverse scenic and visual resources. Generally good air quality and dramatic topography combine to create spectacular vistas. The popularity of scenic and backcountry byways and scenic overlooks illustrates the value and appreciation of scenic quality. Scenic values can also be tied to America's number one pastime of driving for pleasure.

BLM has a basic stewardship responsibility to identify and protect visual values on public lands. These public lands have a variety of visual values, and these values warrant different levels of management. Because it is neither desirable nor practical to provide the same level of management for all visual resources, BLM must systematically identify and evaluate these values.

This evaluation is based upon the apparent visual values of landscapes of similar character as shown on the map *Physical Divisions of the United States* by Nevil M. Fenneman and the U.S. Geological Survey (Fenneman 1946). Therefore, only landscapes of similar character are ranked against each other, thus eliminating the possibility of entire regions of the country being ranked as low-quality scenery when compared to other regions of high-scenic quality.

The visual values are identified through the visual resource management (VRM) inventory and are considered with other resources in the resource management planning (RMP) process. All BLM lands within resource management planning areas are assigned a visual resource management (VRM) class. Class I is assigned to all special areas where a management decision has been made to maintain a natural landscape. Class I areas include designated wilderness, wild sections of wild and scenic rivers, and other congressionally and administratively designated areas where decisions have been made to preserve a natural landscape (i.e. wilderness study areas).

Classes II, III, and IV are assigned by a process that considers scenic quality, viewer sensitivity to changes in the landscape, and distance zones (BLM 1986). Scenic quality, a measure of the visual appeal of a tract of land, is determined by using the seven key factors of landform, vegetation, water, color, adjacent scenery, scarcity (uniqueness), and cultural modifications. Sensitivity, a measure of public concern for changes to the scenic quality, considers the types of users, amount of use, public interest, and adjacent land uses.

Distance zones are based on the premise that the closer a point in the landscape is to the viewer, the more the details are visible and the greater the visual impact from a surface-disturbing activity. Distance zones examine relative visibility from travel routes or observation points and consider whether something is in the foreground-middleground, background, or seldom seen.

From the above information, BLM-managed areas covered by resource management plans (RMPs) are assigned a management class that represents the relative value of the visual resource and prescribes the level of acceptable change in the landscape. The VRM class objectives are described below.

Class I Objective - **No Visible Change**: The objective of this class is to preserve the existing character of the landscape. This class allows natural ecological changes but does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.

Class II Objective - **Change Visible but Does Not Attract Attention**: The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

Class III Objective - **Change Attracts Attention but Is Not Dominant**: The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements in the predominant natural features of the characteristic landscape.

Class IV Objective - **Change Is Dominant but Mitigated**: The objective of this class is to allow management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. But every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

Information Bulletin No. 98-135 (BLM 1998b) recently articulated BLM policy toward visual resources. This policy does not represent a change from current policy but a renewed emphasis on the importance of the program. The information bulletin stated that BLM has a basic stewardship responsibility to manage visual resources on public lands. Local management discretion for decisions on VRM issues is guided by this basic stewardship responsibility and decisions in planning documents. It is BLM policy that visual design considerations be incorporated into all surface-disturbing projects on public lands, regardless of the size or potential visual impact of these projects. The VRM system should not be viewed as a means to preclude development, but rather as a design tool to help management minimize potential visual impacts (BLM 1998b).

BLM does not have information on the national distribution of its lands within the VRM classes. Conflict over scenic values are most likely to occur in areas of high mineral potential in mountains, river valleys, or other areas with high scenic values. The effects of mining on visual management objectives for an area depend on a variety of factors, including the size and type of mine, the basic visual elements of the landscape and the proposed project, and the ability to mitigate visual impacts. The following examples outline potential effects to scenic values under current conditions from two large open pit mines, a placer mine, and a bentonite strip mine.

Impacts to scenic values have the potential to be most severe when a large open pit mine is in an area of high scenic quality. An example of severe impacts to scenic quality can be seen at the mining development at Zortman, Montana, in the Little Rocky Mountains (BLM and Montana Dept. of Environmental Quality 1996).

The Little Rocky Mountains are an isolated area of domed mountains roughly 10 miles in diameter. The rounded crests rise nearly 3,000 feet above the surrounding plains. The topographic relief, colors, and textures of the mountains and their vegetation contrast with the relatively homogeneous terrain, lines, forms, colors and textures of the adjacent plains. In an assessment of the scenic quality of the Little Rocky Mountains, completed in 1979, the area was found to have Class A scenery and was given a Class II VRM rating (BLM and Montana Dept. of Environmental Quality 1996).

Since 1979, disturbance at the Zortman Mine has resulted from mine pits, heap leach pads, waste rock storage areas, roads, topsoil stockpiles, processing areas, and other ancillary facilities. Mining has greatly changed landforms, creating sharp contrasts with the lines, forms, colors, and textures visible in the natural landscape. The scale of the disturbance dominates the viewer's attention.

These contrasts are visible from many of the surrounding peaks and buttes. Recreationists use these peaks and buttes for hiking, picnicking, and wildlife viewing. American Indians use them for cultural purposes. The current disturbance at the Zortman Mine is incompatible with the objectives for VRM Class II landscapes. Topography changes have caused an irretrievable loss of the area's characteristic landscape.

The Bootstrap Project is an open pit mine in the Carlin Trend near Elko, Nevada (BLM 1996c; Treiman 1998). The landscape, which is characterized by broad open vistas framed by scattered hills and mountain ranges, has been given a Class IV designation.

The main impact of the mine is large-scale modification of landforms. Angular, blocky forms and horizontal lines have created moderate contrasts with the natural rounded, rolling hills and ridges of the characteristic landscape. Land clearing and construction of waste rock storage and leach facilities have exposed soil and rock in a variety of colors. The visual impacts of new structures are small when compared to the visually dominant waste rock disposal areas and mine pits.

Mitigation measures developed to reduce visual contrasts include locating facilities in less visible areas, minimizing disturbance, and repeating the basic elements of form, line, color, and texture. Following successful reclamation, the most noticeable residual effect of the proposed action would be the mine pits.

The Birch Creek Placer Mining Final Cumulative EIS (BLM 1988a; McClain 1998) discusses the potential visual effects from placer mining in the Birch Creek watershed about 70 miles northeast of Fairbanks, Alaska. Birch Creek, a national wild river, is managed as part of the Steese National Conservation Area. The landforms are defined mainly by the Birch Creek drainage. The characteristic landforms consist of lower, rounded mountains and hills with bedrock intrusions that have been shaped and dissected by flowing water. The major tributaries of Birch Creek flow through deep, narrow valleys.

The Birch Creek National Wild River has been rated as VRM Class I. But past and present activities–such as placer mining, road construction, and other similar activities that have altered the characteristic landscape–are incompatible with Class I objectives. Mining disturbance is reclaimed, but the surface is revegetated by natural processes. Meanwhile, the cumulative impacts continue to increase.

The Cody Resource Management Plan/EIS (BLM 1988c; Bye-Jech 1998) addresses the effects of bentonite strip mining on visual resources. Before mining, the areas with potential for bentonite development received VRM Class III or IV ratings. Visual quality has declined in specific areas due to bentonite mining but still meets VRM class objectives.

Environmental Consequences

Management Common to All Alternatives

All exploration and mining would operate under the BLM policy that visual design considerations be incorporated into all surface-disturbing projects on public lands, regardless of the size or potential visual impact of these projects (BLM 1998b).

Alternative 1: No Action

Effects to scenic values under No Action would be similar to those described above. Project-specific impacts would depend upon the size and type of the project, the area's topography, the ability to mitigate effects, and other factors. Some projects still might not meet VRM objectives, especially large open pit mines in areas designated Class I or II. Mining in Class I or II areas could contrast in texture, color, form, and line with the natural landscape. This mining could cause a permanent loss of scenic values and scenic integrity and could negatively affect activities such as tourism and recreation that depend, at least in part, on scenic values. Mining development in areas designated Class III or IV would be more likely to meet objectives because more modification of the landscape is allowed.

Alternative 2: State Management

Under State Management adverse effects to the visual environment could be greater than under No Action. Reclamation efforts would be similar, but less emphasis would be placed on scenic quality. Additionally, Alternative 2 would slightly increase mining, increasing the potential for disturbance to visual resources.

Alternative 3: Proposed Action

Under the Proposed Action project-specific impacts would depend upon the size and type of the project, the area's topography, the VRM goals, and the ability to mitigate effects. Overall, the effects to scenic quality would be much less than under No Action because of the revised definition of “unnecessary or undue degradation,” stricter reclamation standards, and less mining overall. Unnecessary or undue degradation would include protecting cultural and environmental resources from harm that could not be effectively mitigated. These resources could include viewsheds of regional or national importance and viewsheds related to cultural areas. Mining development in all classes would be likely to meet objectives.

Alternative 4: Maximum Protection

Project-specific impacts would depend upon the size and type of the project, the area’s topography, VRM goals, and the ability to mitigate effects. Overall, the effects to scenic quality would be much less than under No Action because of much stricter reclamation standards, including mandatory pit backfilling, better road design, and enhanced revegetation standards. Fewer operations would fall under casual use, and much less mining would occur, especially open pit mines, which tend to have the greatest effect on visual resources. Projects would be more likely to meet VRM objectives because of the lessened effects to the visual environment discussed above and the requirements for projects to conform to BLM land use plans.

Alternative 5: NRC Recommendations

Effects to scenic values would be similar to those under No Action. Project-specific impacts would depend upon the size and type of the project, the area’s topography, the ability to mitigate effects, and other factors. Some projects still might not meet VRM objectives, especially large open pit mines in areas designated Class I or II.

Mining in Class I or II areas could contrast in texture, color, form, and line with the natural landscape. This mining could cause a permanent loss of scenic values and scenic integrity and could negatively affect activities such as tourism and recreation that depend, at least in part, on scenic values. Mining development in areas designated Class III or IV would be more likely to meet objectives because these classes allow more modification of the landscape. The magnitude of the effects would be slightly less than for No Action.

CAVE RESOURCES

Affected Environment

Caves can be found in any type of rock as a result of a variety of natural forces. Karst features, depressions, sinkholes, caves, or underground drainages are usually found in sedimentary rocks, notably limestone, dolomite, or gypsum. Caves in igneous rock include flow features such as tubes, lava blisters, and fissures created during eruptions. Overhang and cliff caves may be found in any type of rock. They are usually erosional remnants that can vary in depth and length from a few feet to several hundred feet.

Cave resources are defined in 43 CFR 37.4 as follows:

> "...any naturally occurring void, cavity, recess, or system of interconnected passages beneath the surface of the earth or within a cliff or ledge, including any cave resource therein, and which is large enough to permit a person to enter, whether the entrance is excavated or naturally formed. Such terms shall include any natural pit, sinkhole, or other feature."

This definition excludes abandoned mine tunnels or other human-made features.

The Federal Cave Resources Protection Act of 1988 (FCRPA) provides for the designation of significance based upon the following criteria: biota, cultural, geological/mineralogical/paleontological, hydrological, recreational, and educational or scientific values. Upon discovery, a cave is evaluated to determine its significance. If a cave is determined to be significant, its entire extent, including passages not mapped or discovered at the time of determination, is deemed significant.

To date, 510 caves on federal lands have been designated as significant, and 25 limestone caves have been withdrawn from mining claim location. At least 30 caves have been affected by mining operations of some kind. At least four of these were significantly affected to the extent that they no longer exist.

Where they exist, state laws protecting cave resources are usually limited to resources on state lands or parks or other resources administered by the state. Few states have laws that protect caves regardless of ownership.

Environmental Consequences

Impacts Common to All Alternatives

Impacts to cave resources are actions that would impair or destroy the caves or any of the characteristics that make them significant. These impacts could directly result from mining if a mine were on or next to a significant cave. Impacts, particularly to caves that contain cultural or paleontological material, are not as likely to occur under Plan-level activity as they are under Notice-level activity because Plans of Operations require environmental review procedures that protect cave resources. In caves near mineral operations, fragile cave formations can be disturbed or dislodged by seismic activity. These impacts are often difficult to predict.

Studies on the effect of mining on cave resources are limited, but potential effects can be listed. Exploration, particularly drilling, has the potential to breach the fragile cave environment. Disrupting the air or water movement or temperature in a cave interferes with cave growth and development, speleothem growth, and the maintenance of a healthy ecosystem for cave wildlife.

Any microflora or fauna within the caves have evolved in response to the delicate balance between water and air. Any surface- or soil-disturbing activities that either increase or decrease the amount of air or water within a cave would harm the cave system. Changing the water quality or quantity by aquifer disruption or introducing water into an aquifer could also affect the cave environment. Increased soil erosion and siltation could prevent water infiltration into cave systems by normal routes and adversely alter speleothem growth. Additionally, excessive siltation and sediment loads in the underground streams and pools would have highly adverse impacts on the aquatic wildlife.

The desirability of disturbed caves for recreational use could decrease, and caves could present greater risks to entrants, depending on the degree to which air and water movements have been altered and the amount of blasting and other structural modifications created by mining.

Other impacts to caves might result from increased visitation and vandalism as a result of improved access to new mines being developed in previously remote areas. These indirect impacts could range a considerable distance from a new mine and include inadvertent or intentional damage from visitors or collectors as well as disturbance of bat colonies and other wildlife.

Alternative 1: No Action

Direct impacts are expected to continue to decrease under the No Action Alternative, mainly because of the ongoing implementation of the Cave Resources Protection Act of 1988, an increased awareness of cave resources, and mineral withdrawal of areas with significant caves. Exploration and Notice-level mining would likely continue to damage cave sites. Indirect impacts from existing and new mines would continue at the same rate or slightly less, depending on the number of new mines, the expansion of existing mines, and the success of withdrawals. These impacts would result from increased human activity in an area. As such they are not easily predictable.

Alternative 2: State Management

State laws protecting cave resources vary. Six western states have statutes that give some protection to cave resources but none to the same extent as the Federal Cave Resources Protection Act. In those states impacts to caves might increase slightly. In the western states without cave regulatory protection, cave resources are likely to experience an increase in adverse effects. States lacking an equivalent to the National Environmental Policy Act are not likely to consider wildlife, cultural, or paleontological values in caves. Impacts to caves containing these resources would increase. Indirect impacts to existing and new mines would continue.

Alternative 3: Proposed Action

Specific language directed at cave resources in the proposed regulations and the defining of unnecessary or undue degradation to include scientific values would increase the consideration of caves in the evaluation of both Notice- and Plan-level operations. This consideration might prevent both direct and indirect impacts. Specifically, impacts from Notice-level mining would likely be reduced because of new definition of unnecessary or undue degradation.

Alternative 4: Maximum Protection

Under Maximum Protection, all mineral activity that could cause disturbance exceeding casual use would require a Plan of Operations and would be subject to a thorough review by BLM. The elimination of Notices would reduce impacts to all cave resources. Also, greater emphasis upon land use planning documents would further protect caves.

Alternative 5: NRC Recommendations

Impacts to Cave resources under this Alternative would result from incidental use and exploration. All other activities would require a Plan of Operations which would provide for environmental review and greater protection of cave resources.

PALEONTOLOGICAL RESOURCES

Affected Environment

Paleontological resources are the remains of plants and animals preserved in soils and sedimentary rocks. They are important for understanding past environments, environmental change, and the evolution of life. Paleontological resources can be found in any sedimentary formation or soil deposition context. The highest potential exists in badlands shale, sandstone, limestone outcrops, adjacent fault scarps, and eroded lands.

The Federal Land Policy and Management Act directs agencies to manage paleontological resources to preserve them for scientific and public uses. Paleontological resources have not been systematically inventoried on most BLM-administered lands.

BLM has found 5 million acres of sensitive fossil-bearing geological deposits on western federal land. The fossils range in age from the Precambrian (more than 500 million years ago) to the recent (the last 10,000 years) and include examples of all extinct and living phyla. Paleontological remains include mammoths from the Ice Age, about 10,000 years ago, to the microorganisms that constitute the earliest evidence of life some 2.8 billion years ago. Paleontological remains discovered on federal land include dinosaur remains in Alaska, Nevada, Utah, Colorado, Wyoming, California, and Montana; fossil fish deposits in the Green River Formation of Wyoming; insect and plant fossils in Nevada, large petrified trees in Arizona and Nevada, and recent-age fossils in Alaskan deposits.

Mineral activities can benefit paleontological research when significant resources are discovered, reported, and recovered as a result of activities ranging from exploration to extraction. The removal of overburden during mining can expose fossil-bearing formations for inspection and possible discovery. But surface-disturbing activities can harm paleontological resources if deposits are not recognized or reported and significant fossil information is displaced or lost.

Since 1981 paleontological resources have been found in no more than 3% of Notice-level operations, mainly in Utah, Montana, and Wyoming. In Alaska the number is higher; 26% of Notice-level operations have found paleontological remains because of the higher proportion of placer mining there. BLM has issued no notices of noncompliance for damage to paleontological resources.

Paleontological resources have been found during Plan-level activity in most states. New Mexico, Oregon, Washington, Utah, Alaska, and Montana have had paleontological resources discovered from 6% to 10% of the time during mining. In the other states paleontological resources have been found in 1% or 2% of Plan-level operations. In Plan-level operations mitigation measures are used to reduce the impact and prevent the loss of information.

Environmental Consequences

Alternative 1: No Action

Impacts to paleontological resources from Notice-level activity would continue at the present rate of 26% of all Notices submitted in Alaska, to about 3% of all Notices submitted in the other states. Plan-level operations would continue to have both adverse and beneficial impacts at the present rate.

Alternative 2: State Management

Under Alternative 2, operators might not recognize or report paleontological resources. Few states have laws protecting paleontological resources, and most protection is restricted to state land. Depending on the state program, much paleontological resource and associated site information could be lost.

Alternative 3: Proposed Action

Increased protection or preservation of paleontological resources would result from requiring Plans of Operations for private surface overlying federal minerals. The Proposed Action would slightly reduce impacts to paleontological resources from both Notice- and Plan-level activities because sensitive lands would be included in the category of disturbances requiring Plans of Operations.

Language directed at paleontological resources in the proposed regulations and the defining of "unnecessary or undue degradation" to include scientific values, would increase BLM's consideration of paleontological resources in evaluating mineral activity. This consideration might prevent both direct and indirect impacts. Specifically, impacts from Notice-level mining would likely decline because of new definition of unnecessary or undue degradation.

Alternative 4: Maximum Protection

The Maximum Protection Alternative would reduce the potential for impacts to paleontological resources. Paleontological resources on private surface overlying federal minerals would also be inventoried and recovered. Paleontological information would no longer be lost from Notice-level activity because all mining and exploration would require Plans of Operations.

Increased time frames for Plan review would allow more extensive examination of proposed disturbance areas to determine either the existence of fossils or the potential for the area to produce significant fossils. The unlimited time period for evaluating and recovering fossils discovered during operations would allow for complete data recovery in areas containing complicated fossil deposits.

Alternative 5: NRC Recommendations

Most impacts to paleaontological resources occur from mining and all mining activities under Alternative 5 would now require a Plans of Operations which would lead to better protection paleontological resources then Alternative 1.

CULTURAL RESOURCES

Affected Environment

Cultural resources are the fragile and nonrenewable remains of human activity. They are found in sites, districts, buildings, and artifacts that are important in past and present human events. Cultural resources are arbitrarily divided into historic and prehistoric cultural properties and traditional lifeway values, although they are part of a continuum of human use and occupation of the land.

A traditional lifeway value is important for maintaining a traditional system of religious belief, cultural practice, or social interaction for a contemporary ethnic or cultural group or community. Shared traditional lifeway values are abstract, nonmaterial, ascribed ideas that cannot be discovered except through discussions with members of the particular group. Lifeway values may or may not be closely related to narrowly defined locations.

As of 1999, about 5.7% of the BLM-administered lands had undergone cultural resource inventories. As a result, 227,993 sites have been recorded with 19,297 properties found to be eligible for listing on the National Register of Historic Places. In addition, certain areas have been designated at least in part because of their cultural resource content. Table 3-28 shows the numbers of nationally significant designated cultural resource areas.

Table 3-28. Designated Nationally Significant Cultural Resource Areas

Designation	Number	Estimated Acreage
National Historic Trails	8	1,271,880 (3,590 miles)
National Register Properties Listed	3,610 Contributing Properties* 255 Listings	NA
National Historic Landmarks	22	117,167
Areas of Critical Environmental Concern	123	1,428,960

*Buildings, sites, structures, or objects adding to the historic significance of a property.

Prehistoric Resources

Prehistoric properties in the United States extend back to the earliest human migrations to the Western Hemisphere, some 15,000 years ago. Prehistoric properties range from isolated artifacts, through small-scale habitation sites, to complex agricultural villages and densely populated pueblos. Prehistoric human occupations were rarely uniform over large areas, particularly where there were significant ecological changes over short distances. Consequently, site types, sizes, and densities are extremely variable. American Indians typically consider prehistoric resources to be ancestral sites.

Prehistoric cultural resources have been organized into early, middle, and late periods, with the early period commonly called Paleo-Indian (15,000 to 8,000 years ago), the middle period Archaic (8,000 to 2,000 years ago), and the final period Late Prehistoric (2,000 to 200 years ago).

Cultural resources from the Paleo-Indian period are found in high-elevation coniferous and deciduous forests and also lower elevation plains grasslands and in parts of the desert Southwest, mainly near water sources and in alluvial and colluvial soil deposits. People during this period often hunted megafauna, such as mammoth and giant bison, which are now extinct.

Prehistoric cultural resources from the Archaic period reflect a shift from an exploitation of megafauna to an emphasis on hunting and collecting a variety of resources, such as fish, large and small game, and edible plants and nuts. Hunting sites, plant gathering sites, and temporary camps are likely scattered in most western ecosystems.

Beginning about 2,000 years ago the Archaic period phased into the Late Prehistoric period with the introduction of agriculture, ceramics, the bow and arrow, and sedentary lifeways as major adaptive elements. In general, site types and patterns were the same as during Archaic times except where lifeways shifted to an agricultural base.

The Prehistoric era began blending into the Historic era in 1492, when Europeans started significant migrations to the Americas. The Historic era began in the Southwest and California in the 1500s with the Spanish entrada. In the Pacific Northwest and the Great Basin significant migration effects did not begin before the middle of the 1800s. In the Rocky Mountains and Plains the Historic era did not begin until the exploitation of the region by the fur trade in the late 1700s and early 1800s.

Historic Resources

Cultural properties of the Historic era continue to include indigenous materials, but the resources are now dominated by artifacts, sites, and landscapes of early Euro-American exploration, the fur trade, mining, logging, ranching, farming, transportation, manufacturing, and urban development.

Beginning about 1900 the Historic era blends into modern times although certain elements of traditional and historic cultures and lifeways are sometimes preserved. For example, American Indians continue traditional religious beliefs and practices and in many cases have maintained tribal uses of traditional plant gathering and hunting. Also, other native Americans retain values, sometimes as an occupation, in the land and its use and accessibility. These “Old West” attitudes are deeply held by the families who have owned land and lived for generations in the same area.

Traditional Cultural Resources

Traditional cultural properties and traditional lifeway values include areas for gathering plants, animals, or minerals that are important to American Indians and other cultural groups. They also include areas and landscapes that embody religious symbolism or are required for ritual practices. Rural historic landscapes that exemplify a historic lifeway, such as ranching or mining, may be important. Traditional cultural properties may also have historical significance from events such as battles or other local, regional, or national historic events.

Historic Impacts to Cultural Resources

There are three main sources of impacts to cultural resources. Vandalism to sites includes unauthorized collection, excavation, or defacing and is the most common source of loss of values. Impacts from vandalism increase as population increases and as access to an area improves. It is difficult to measure this type of impact. But where population increases, such as at mine openings, the amount of vandalism generally increases.

Loss of site information, material culture, or in situ information from unauthorized or inadvertent activity, such as an off-road vehicle use and sometimes casual use and Notice-level activity, is the second type of impact. Again, measuring this type of impact is difficult, and impacts sometimes go unnoticed for a long time.

Finally, previously unknown cultural resources, such as buried material with no surface indication, can be disturbed. Often a large portion of these types of resources can be destroyed before being noticed. If enough of this type of resource remains upon discovery by the operator, the recovery of the information would be a net benefit to cultural resources.

Before authorizing surface disturbance, BLM must determine what cultural resources are eligible for inclusion on the National Register of Historic Places and consider the effects of the proposed undertaking through the consultation process in Section 106 of the National Historic Preservation Act (NHPA) of 1966. This process is implemented according to 36 CFR 800. In many states, procedures for adapting the process to local needs have been developed through programmatic agreements among BLM, the state historic preservation officer, and the Advisory Council on Historic Preservation.

Section 106 of NHPA does not prohibit disturbing cultural resources. In fact, BLM may permit activities that result in adverse effects if mitigation cannot preserve all site information. Often this is the loss contextual information about the site, its existence within a particular ecological zone, or the inability to apply evolving techniques of data recovery. In addition, mitigation is required only if disturbance would affect a resource’s attributes that make it eligible for the National Register. The one who would be mitigating the damage might ignore the attributes not considered significant to the site’s eligibility.

In recent years, with an awareness and appreciation of cultural resources, properties and traditional lifeway values, the inventory, protection, stabilization, and enhancement of cultural resources have become an integral part of BLM procedures. While recovery of cultural resource information results in a loss of some in situ information, this loss of information is slight under most mitigation.

Casual use and Notice-level activity are not federal actions or undertakings and therefore do not require consultation under the National Historic Protection Act. But to meet the broad management responsibilities for cultural resources under the Federal Land Policy and Management Act, Archeological Resources Protection Act, National Environmental Policy Act, and National Historic Preservation Act, cultural resource specialists routinely review Notices. This involvement ranges from 50% to 100% of cases. In less than half of the cases, trained nonspecialists have been used to recognize resources for evaluation by specialists.

Notice-level actions disturb cultural resources, but nationwide only about 3%, on the average, of these actions either require mitigation or actually damage cultural resources. Of these 3%, only1% were listed on the National Register. BLM has issued eight notices of noncompliance since 1981 for damage to cultural resource sites. Only two of these sites were on the National Register.

The approval of Plan-level activities requires compliance with the National Historic Preservation Act. This process includes review by BLM cultural resource specialists. Generally, on-the-ground inventories are required for all potentially affected areas. Resources discovered during inventories are evaluated to determine their eligibility for inclusion on the National Register and how they would be affected by the Proposed Action.

Since 1981, up to 30% of the Plans of Operations submitted have involved prehistoric resources, and up to 50% have involved historic resources. The notable exception is in Alaska, where 92% of Plans of Operations submitted since 1981 have involved historic resources. BLM evaluated all of these sites according to existing regulations and found only 10% or fewer eligible for the National Register. Since 1981 BLM has issued only one notice of noncompliance for damage to cultural resources.

The benefit of mineral activity has been the addition of information to prehistory and history from the inventory and evaluation of sites in disturbance areas. The major contributions have been from processing Plans of Operations and, to a lesser extent, Notice reviews. If recognized in time, resources discovered during operations can contribute valuable information on cultural resources.

State laws protecting cultural resources vary. Burial laws are common to most states and are usually not specific to prehistoric or historic remains. These laws commonly require notifying the local coroner should a burial or human remains be discovered. State laws protecting prehistoric or historic sites are normally effective only on state-owned lands. In some cases these laws extend to private land where state or federal funds are involved.

Environmental Consequences

Recent Regulatory Changes Affecting Impacts under Alternatives 1, 3, 4, and 5

Since the completion of the draft EIS, changes in the 36 CFR 800 regulations now require consultation with tribal historic preservation officers. When Indian tribes and Native Hawaiian organizations attach religious and cultural significance to historic properties on and off tribal lands, consultation is required under section 101(d)(6)(B) of the National Historic Preservation Act. This consultation will reduce impacts to traditional cultural places and properties that have religious or cultural significance.

Alternative 1: No Action

Impacts to cultural resources would continue under Notice-level activity. The number of sites affected is expected to stay at the same level, about 3% of all cases. The recovery of site material during mine operations would benefit cultural resources.

Alternative 2: State Management

Mineral activity could increase by an estimated 5% under the State Management Alternative. State programs by themselves would generally not mitigate impacts to cultural resources or recover data from disturbed sites. Both the increased potential for disturbance and the lack of data recovery would significantly harm cultural resources.

Alternative 3: Proposed Action

For several reasons the Proposed Action would reduce impacts to prehistoric, historic, and traditional cultural resources for both Notice- and Plan-level activities. First, operators would submit fewer Notices and proportionally more Plans due to the expansion of special status areas. Overall, a more detailed cultural resource review would improve opportunities for recognizing and mitigating development and would better protect cultural resources.

Second, the amount of time allowed for recovering data from cultural resources discovered during operations would increase to 30 calendar days. This increased time would allow better or at least more complete recovery of data from cultural resource discoveries.

Third, the addition of split-estate lands with private surface ownership over federal minerals would occasionally allow data recovery and protection of cultural resources on these other lands.

Finally, the language used in the expanded definition of "undue or unnecessary degradation" standard to include "substantial irreparable harm to significant scientific, cultural, or environmental resource values of the public lands that cannot be effectively mitigated" implies that consultation through the National Historic Preservation Act (36 CFR 800.6(a)) will be completed where the standard is to be met. Therefore, both Notice- and Plan-level activities could involve consultation with state historic preservation officers and tribal historic preservation officers, reducing impacts to these resources.

Mineral activity under the Proposed Action is expected to decrease slightly from current levels. Although this decrease means fewer opportunities for cultural resource inventory and data collection from mining sites, it also means less potential to harm cultural resources. These two effects would be about equal. A decrease in mineral activity would benefit cultural resources on traditional cultural properties, national historic trails, or other areas where mining disrupts the setting of a historic property.

Alternative 4: Maximum Protection

For several reasons Alternative 4 would give the most protection to cultural resources of all alternatives. First, Notices would be eliminated. All previous Notice-level activity would have to be conducted under Plans of Operations, resulting in more detailed cultural resource reviews with improved opportunities for recognizing and mitigating development. Cultural resources would be better protected.

Second, the amount of time allowed for the recovery of data from cultural resources discovered during operations would increase from 10 working days to an unlimited time period. This time frame would give sites discovered during mining a sufficiently detailed recovery strategy commensurate with their significance, resulting in improved or at least more complete recovery of data from cultural resource discoveries.

Third, the addition of split-estate lands with privately owned surface over federal minerals, and lands with BLM-managed surfaces only would allow for data recovery and protection of cultural resources on other lands.

Also, the amount of mineral activity is expected to decrease from current levels. This decrease means a decrease in opportunities for cultural resource inventory and data collection for mineral projects. But this decrease also means less potential to harm cultural resources. Since all activity potentially affecting cultural resources could be controlled under Plans of Operations, the decrease in data collection opportunities from sites would outweigh any benefit of decreased mineral activity.

Alternative 5: NRC Recommendations

Alternative 5 would eliminate impacts from Notice-level mineral activities other than from exploration.

AMERICAN INDIAN RESOURCE CONCERNS

Affected Environment

American Indians sometimes use BLM-managed public lands for a variety of traditional purposes. They may use the lands to gather native plants, animals, and minerals for use in religious ceremonies, rites of passage, folk medicine, subsistence, crafts, and other traditions. Contemporary use areas often include traditional plant and mineral collection locales, vision quest sites, sun dance grounds, shrines, and traditional trails. Lands with a history of traditional use or having traditional lifeway values may be eligible for listing on the National Register of Historic Places as a traditional cultural property (TCP).

Because of their combination of geology with topography, lands used by American Indians for traditional cultural practices or having traditional cultural resources often contain valuable mineral deposits that are the focus of exploration and development. Conflicts over mineral activities in these areas are becoming increasingly common. Individual American Indians often view these lands as sacred and regard any disturbance or intrusion in these areas as desecration that cannot be mitigated.

Sometimes the use of the public lands is subject to treaties between the United States and a particular tribe. Treaty rights are often defined from the "canons of treaty construction":

- That ambiguities must be resolved in favor of the Indians.
- That treaties must be interpreted as the Indians would have understood them.
- That the treaties must be construed liberally in favor of Indians.

Since these treaties were signed between sovereign nations, the retained rights have a constitutional basis. These rights may include access to and use of "unoccupied federal land" in the conduct of daily lives, usually for subsistence activities. The exercise of treaty rights would supersede the requirements or procedures in the 3809 regulations and is outside the scope of the regulations.

Regulatory Statutes and Executive Order 13084

The American Indian Religious Freedom Act of 1978 (AIRFA) and Executive Order 13007 require federal agencies to evaluate their policies and procedures to protect the religious freedom of American Indians. AIRFA was passed as a joint resolution of Congress and has no implementing regulations. The intent of AIRFA is to preserve for the American Indian the inherent freedom to practice traditional religions, including access to religious sites, use and possession of sacred objects, and freedom to worship through traditional ceremonies.

In American Indian religious practice, any geographic area can contain places that are significant for sacred practices or purposes. Those sacred places may embody spiritual values of specific landforms, indigenous rock art, medicine wheels, rock caims, effigy figures, spirit trails and gates, caves, springs or lakes, Indian graves, and contemporary use areas. AIRFA requires agencies to consult with American Indians on religious use of an area but does not give that use controlling authority over other uses.

The Native American Graves Protection and Repatriation Act protects American Indian burial sites and access to them, prohibiting the desecration and removal of these sacred sites and associated materials. These sites may not be generally known but may be found through formal inventory, archaeological studies, or inadvertent discoveries.

Congress and the U.S. Supreme Court have affirmed the trust responsibility between the tribes and the United States. This doctrine relates to reservation and nonreservation lands where federal or federally authorized activities may affect tribal resources or the quality of life on the reservation.

Executive Order 13084, signed May 14, 1998, requires "regular and meaningful consultation and collaboration with Indian tribal governments in the development of regulatory practices on Federal matters that significantly or uniquely affect their communities; to reduce the imposition of unfunded mandates upon Indian tribal governments; and to streamline the application process for and increase the availability of waivers to Indian tribal governments." Because tribal lands are not defined as "federal lands" in the existing or proposed regulations and because the purpose of the executive order is to reinforce tribal standards rather than impose unfunded mandates on the tribes, this executive order is not likely to affect the applying of the regulations

The Alaska National Interest Lands Conservation Act (ANILCA) protects Native Alaskan and rural population subsistence activity on public lands. This act provides that the agency consider the affect of its actions on subsistence efforts of these groups. This consideration is applied as agency permit activity on a site-specific basis.

Generally, the states have no regulatory statutes for consulting with federally recognized tribes. But states do consult with tribes as they would with the public or a local division of government.

Historic Impacts

Consultation with recognized tribes has been inconsistent in the past. Since the 1980s consultation has become an increasingly important part of authorizing activities and planning.

Although not federal actions, BLM has conducted a limited number of consultations on Notice-level activity with tribal governments. The highest level of consultation occurred in New Mexico with 20% of the Notices. There is no record of consultation in six of the 11 BLM western states in the study area (not including Alaska). Tribal governments have either commented on or objected to 5% of the Notices in Montana.

Where BLM has played a definitive role in authorizing activities under a Plan, its consultation with tribes has been more consistent. Since 1990 most BLM states have actively sought comment from tribal governments on Plans of Operations, with an average of 27% of the Plans being submitted for consultation and 4% being amended or changed in response to consultation.

In several cases surface disturbance under Notices or Plans has adversely affected or had the potential to affect localities important to American Indian traditional lifeway values or traditional cultural properties eligible for the National Register. Despite consultation, some American Indians regard surface-disturbing activities in certain areas as desecration. Such disturbance cannot be mitigated to eliminate American Indian objections to the actions.

Few state regulatory programs have mandated consultation on any issues outside the designated reservation on either state or private land.

BLM has addressed subsistence activities, particularly as related to Alaska National Interest Lands Conservation Act (ANILCA), in several-site specific placer mining EISs from Alaska: Fortymile River (BLM 1988d), Birch Creek (BLM 1988a), Beaver Creek (BLM 1988b), and Minto Flats (BLM 1988e) EISs. These documents have discussed potential impacts to subsistence activities. In general, placer mining could affect subsistence uses and needs in the following ways:

- By reducing potable water quality of a stream used as a source of drinking water.
- By disturbing or destroying fisheries, animal populations, or habitats that support subsistence fishing, hunting, or trapping.
- By increasing harvest through creating more or better access routes into an area.
- By causing sedimentation of waterways, which impedes human access to subsistence resources.

Each of the EISs found that mining would pose no more significant restrictions to subsistence activities and that applying performance and reclamation standards, in some cases, would have a net beneficial effect to access and water quality.

Environmental Consequences

Recent Regulatory Changes Affecting Impacts under Alternatives 1, 3, 4, and 5

Since the completion of the draft EIS, changes in the 36 CFR 800 regulations now require consultation with tribal historic preservation officers. When Indian tribes and Native Hawaiian organizations attach religious and cultural significance to historic properties on and off tribal lands, consultation is required under section 101(d)(6)(B) of the National Historic Preservation Act. This consultation will reduce impacts to traditional cultural places, and properties that have religious or cultural significance by requiring mitigating measures to be examined with tribal historic preservation officers.

Alternative 1: No Action

Consultation with potentially affected parties would continue to improve as a result of recent executive orders and management guidance on BLM's responsibility to the tribes. Tribal governments would also continue to play a more assertive role in land use planning to protect areas of traditional cultural importance.

Despite complete consultation, mineral exploration and development could harm some areas of traditional cultural importance. Residual impacts can be expected to continue from Notice-level activity because of the nondiscretionary nature of activities under the Mining Law and the inability to mitigate impacts to American Indian values.

Potential adverse impacts to subsistence rights are expected to continue as in the past (see Historic Impacts from Mining section under the Affected Environment above) and would continue to be considered on a site-specific basis.

Alternative 2: State Management

Adverse impacts to American Indian traditional cultural practices and resources are likely to increase under State Management. The level of mineral activity would increase slightly, and the greater the level of activity, the greater the potential for impacts. More importantly, most states do not have a mandate for consultation. Nor do they have a trust responsibility to protect tribal rights. Opportunities would decline for tribes to consult with the permitting authority on mitigating measures that could reduce impacts to their traditional cultural values.

The State of Alaska is not bound by the provisions of the Alaska National Interest Lands Conservation Act (ANILCA) to address impacts to subsistence activities. Exploration or mining could result in more adverse impacts to subsistence activities without applying the provision of ANILCA.

Alternative 3: Proposed Action

Adverse impacts to American Indian traditional cultural practices and resources are likely to decrease under the Proposed Action. The level of mineral activity would slightly decrease because the lower the level of activity, the less the potential for impacts.

Impacts would also decline because of increased levels of consultation with American Indians. The increase in special status areas and added requirement for when BLM would require Plans of Operations would result in more complete reviews of proposed activity and provide for extended consultation with American Indians.

But even improved consultation and reduced levels of mineral activity would not eliminate adverse impacts to areas of traditional cultural importance. Some residual impacts would continue from Notice-level activity because of the nondiscretionary nature of activities under the Mining Law and the inability to mitigate certain impacts to American Indian values.

The language used in the proposed definition of "unnecessary or undue degradation" would prohibit standard to include "substantial irreparable harm to significant scientific, cultural, or environmental resource values of the public lands that cannot be effectively mitigated." This means that consultation through the National Historic Preservation Act (36CFR800.6(a)) would be used where the standard is to be met for Plan-level activities affecting historic properties.

Effects from Notices would still be considered, and consultation might still occur, but such actions would be outside the National Historic Preservation Act process because Notices are not federal undertakings.

Under the proposed regulations processing both Notices and Plans would involve increased consultation and consideration of Native American resource concerns, thereby reducing impacts to these resources or perhaps preventing harm by denying operations where the resource is significant and mitigation would not be effective. Traditional cultural resources would significantly benefit.

Potential impacts to subsistence rights would continue as in the past (see Historic Impacts from Mining section under Affected Environment above), and BLM would continue to consider these impacts on a site-specific basis.

Alternative 4: Maximum Protection

Adverse impacts to American Indian traditional cultural practices and resources would decrease substantially under the Maximum Protection Alternative. The level of mineral activity would decrease moderately, and the lower the level of activity, the less the potential for impacts. Adverse impacts would also decrease because of increased levels of consultation with American Indians.

The elimination of Notices would make all activity above casual use subject to the review and consultation requirements of Plans of Operations. This change would result in more complete reviews of proposed activity and provide for extended consultation with American Indians to mitigate impacts.

In addition, BLM would require concurrence by potentially affected American Indians before approving surface disturbance on lands with traditional cultural importance, or lands used for traditional cultural practices. This requirement would greatly reduce or prevent adverse impacts to American Indian traditional cultural practices and resources.

The inclusion of split-estate lands under the 3809 regulations would give American Indians more opportunity to consult and mitigate impacts where, in the past, surface ownership has prevented such consultation or rendered it moot.

Potential adverse impacts to subsistence rights would continue as in the past (see Historic Impacts from Mining section under Affected Environment above), and BLM would continue to consider these impacts on a site-specific basis.

Alternative 5: NRC Recommendations

Alternative 5 would eliminate impacts from Notice-level activities other than exploration. A decline in impacts would continue as a result of more complete consultations.

SOCIAL CONDITIONS

Affected Environment

Demographic and Social Trends in the West

In 1999, the population of the 12 western states in the EIS study area was 60 million. While these 12 states contain nearly half of the area of the United States, they are home to only 22% of the Nation's population. California has the largest population with more than 33 million residents. Alaska, Montana, and Wyoming each have fewer than a million people. Population densities vary from fewer than 5 people per square mile in Wyoming to more than 200 people per square mile in California. Though the area's population grew by 16% between 1990 and 1999, individual states varied. Nevada and Arizona grew the fastest, increasing by 51% and 30% respectively. Wyoming, Montana, and California grew the slowest at 6%, 11%, and 11% respectively.

In the rural West, population and social trends tend to respond to unique issues. Many areas are experiencing a significant increase in population after decades of stability or decline. Other rural areas continue to lose population due in part to the outmigration of young people who leave for advanced education, military service, and employment. Still other rural areas are subject to the population and employment boom-and-bust cycles of mining and other resource development.

The movement of people and jobs into some rural areas began in the 1970s and is expected to continue into the 21st century. The migration turn-around reflects a reversal of the rural-to-urban migration pattern found in most of the United States before the 1970s. Intermountain valleys, the settings for such places as Salmon, Idaho, and Missoula, Montana, typically experience inmigration. In scenic areas, particularly those suitable for recreation, ranches are being sold for recreation uses or subdivided for homes. Some inmigrants buy small lots to ranch or farm but do not depend on an economic return from the property. These rural areas are moving from a long-term economic dependency on agriculture, logging, or mining to a dependency on recreation and tourism. This population inmigration has increased contacts between long-time rural residents and newcomers whose beliefs and values may challenge the existing way of life. Long-timers may feel they have lost control of their community, making it a less desirable place for them to live.

Other rural areas have continued to lose residents in the last decade. These communities typically have had economies based on agriculture, logging, oil and gas, or other mineral development and have suffered declines in population as agriculture mechanized and mineral development efforts came and went (boomed and busted). Some of these communities have difficulty maintaining their local businesses as well as such services as schools and health care. Residents are concerned about the economic survival of their communities and preserving their traditional lifestyles. While these communities can be located in many regions of the study area, many of them are on the western edge of the Great Plains in central and eastern Montana and Wyoming.

Major cities in the West–Denver, Seattle, Phoenix, Salt Lake City, San Francisco, and Los Angeles–have experienced significant growth over the last few decades. These urban centers are often the areas where environmental attitudes are most pronounced and many environmental groups have headquarters.

National and Regional Attitudes

Discussions about changes in the 3809 mining regulations are just one aspect of a broader debate on environmental issues and resource management that is occurring both in American society and globally. According to the report of the Forest Ecosystem Management Assessment Team (FEMAT) (1993), "This growing concern with the environment, from the international to local levels, appears linked to some fundamental structural changes taking place in industrialized societies. Shifts in education levels, population distribution, and composition and make-up of the labor force all combine to bring increased concern with issues related to the quality of life and other types of personal attitudes, including natural resources and the environment."

According to Stankey and Clark (1991), social values for lands and natural resources take many forms:

- Commodity values: timber, range forage, minerals.
- Amenity values: lifestyle, scenery, wildlife, nature.
- Environmental quality values: air, water quality.
- Ecological values: habitat conservation, sustainability, threatened and endangered species, biodiversity.
- Public use values: subsistence, recreation, tourism.
- Spiritual values: sacred places, wilderness areas.
- Health: medicines.
- Security: sense of social continuity and heritage.

In the past, natural resource management has tended to emphasize commodity values. The emerging emphasis on other values has forced a reevaluation of the commodity emphasis. Stankey and Clark's (1991) report states, "A new focus on the part of the public involved a shift from commodities and services to environments and habitats." More profoundly, these changing value orientations within society have led to changing expectations concerning the management of public lands.

A nationwide survey conducted by Roper Starch Worldwide (1997) offers some interesting information on attitudes toward environmental issues and regulations. When asked what was the leading environmental issue we face today, pollution was named by 60%, with 41% of respondents specifying air pollution and 29% specifying water pollution. Of the survey respondents, 65% said that environmental protection and economic development can go hand in hand. But nearly 70% said that when a compromise cannot be reached, they would choose the environment, while 15% would choose economic development.

Respondents to this survey were also asked whether they thought environmental laws and regulations had gone too far, had not gone far enough, or had achieved the right balance. Almost three times as many respondents thought laws and regulations had not gone far enough (46%) as those who thought laws and regulations had gone too far (17%). Just over a quarter of the respondents (27%) thought the laws had struck the right balance; 29% of respondents living in rural areas and 27% of respondents living in the West stated that environmental regulation had gone too far.

The following percentages of respondents stated that laws and regulations had *not* gone far enough in confronting the following environment issues:

- 72%, preventing water pollution.
- 62%, preventing air pollution.
- 48%, protecting wild or natural areas.
- 44%, protecting wetlands.
- 41%, protecting endangered plants and animals.

A counter-movement has been growing in the West. Where land use has been relatively unrestricted, there is increasing concern about the management and regulation of public lands. People with these concerns feel that change in public land management is being driven by government officials and environmental advocacy groups who do not have a true understanding of the lands or nearby residents who depend upon these lands for their livelihood and recreation. There is particular concern about the loss of traditional land uses such as livestock grazing, mining, and off-road vehicle use. People with these concerns seek to balance what they consider to be environmental extremism with economic and human concerns.

In scoping and other comment letters, some writers said that the freedom to engage in mining is part of the American heritage. They feel the romance and lure of prospecting and treasure hunting have been key components of our culture and history. As one commenter stated,

> We in the West are proud of our mining heritage. In past generations, miners walked into unknown, hostile country to search for minerals to advance the new industrial age, without which we would not have the standard of living we do today. They were the ultimate pioneers because they came alone, not in wagon trains with many others to provide personal safety. They helped settle the West as much as farmers, ranchers and merchants, and, without their discoveries, the railroad would not have been encouraged to extend westward. This country would not have grown and become the great power it is today with minerals discovered by these mining pioneers.

Miners

This section will focus on small "mom and pop" type operations (up to three or four people) that function without outside financial backing. These operations may engage in exploration or small placer, open pit, or underground mines although they are most likely to engage in exploration or placer mining. Most of this activity operates as casual use or under Notices because these operations disturb less than 5 acres. The number of these miners is declining overall, although some new people are entering the field. In some cases several generations of a family work a claim. Some have family members employed outside the mine for more financial support. Many of these miners live an independent, solitary, self-sufficient lifestyle, especially in Alaska. These miners may also be mechanics, pilots, loggers, and skilled in construction; a variety of skills helps them maintain their independent lifestyle.

Some operations offer large financial rewards; others are marginal. Some miners from Alaska spend the summers mining and the winters in the lower 48 states. In the other 11 states in the study area some people spend their summers in northern states such as Idaho and their winters in places like Arizona working their claims. Little is known about these miners from a sociological standpoint. They do, however, appear to identify highly with their occupation and the lifestyle of that occupation and would resent being forced to change either.

Communities

The effects of mining on a rural community can be divided into four phases: exploration, development, production, and phase down or closure (Wenner 1992).

During exploration, the major effects would be increased business volume for motels, restaurants, and gas stations, plus some temporary employment for local residents. During this phase, local residents and special interest groups may become aware of potential nearby mineral development. The intensity of their reaction varies from one project to another depending on factors such as local economic conditions, existing land uses, local lifestyles, outdoor recreation preferences, the ecological sensitivity of the development site, and the way in which the proposed activity is designed and presented to the public. In general, local facilities and services do not need to significantly expand for exploration.

Site development is often the most labor-intensive phase of operations and can cause more social impacts than exploration and production because the workforce is larger. During this phase, employment opportunities for local residences and local expenditures might benefit some local residents. Rural counties and communities can be seriously overburdened if the firms involved fail to provide the housing and services their new employees require. The negative consequences of rapid development, such as increased crime rates and increased need for mental health services, are most evident under such conditions.

The production phase is ordinarily the most stable and enduring phase of a mineral operation. A major mine may operate continuously for two or three generations. Its presence in a relatively rural area is imposing and influences the social organization, outlook, and lifestyles of nearby communities.

The rate of population change is the single most important factor affecting community well-being, contributing to prosperity and infrastructure improvements in some instances and to economic instability, social disorganization, and adverse social conditions in others. As time goes on, community facilities expand to meet the needs of the newcomers, and they become integrated into the community.

A phase down or closure of a large mine can be a traumatic experience, especially for small communities in sparsely populated areas. The loss of well-paid jobs and the resulting outmigration can affect real estate values, the volume of local business activity, school enrollments, organizational membership, and the economic security and outlook of most of the resident population.

Communities come in a variety of forms and sizes, resulting in differing abilities to adapt to change. One study for the Interior Columbia Basin Ecosystem Project (Harris and others 1995) categorized communities by a variety of factors and determined the qualities that make a community "resilient" or able to manage change. According to the study, the qualities that allow communities to manage change include the following:

- Strong civic leadership.
- Strong economic structure.
- High degree of physical amenities.
- Positive, proactive attitude toward change.
- Large population.

Residents of small communities that rely on mining have voiced many concerns during this process. These concerns include effects to employment, families, lifestyles, and communities. Some said that the loss of high-paying jobs is particularly difficult where high-paying jobs are hard to find, and that mining employment, even if it doesn't last forever, can enable someone in the family to go back to school, or allow a family to purchase a home. Others said that some farms and ranch operations get through hard times when someone in the family finds a job in the mining industry.

Some also discussed the dependency of rural communities on tax monies and skills provided by the mining industry. Some stated that mining can give a small community technical expertise that a community of that size would not normally have, and that mining companies are good neighbors.

Environmental Advocacy Groups

During the scoping period, BLM received many letters from environmental advocacy groups stating their support for changes in the surface management regulations. Comments from the different groups were similar, and some groups submitted joint comments. These groups believe that active and abandoned mines continue to inflict substantial environmental damage on public lands in the study area and that strengthening the regulations could result in real environmental gains. Specific ideas included the following:

- Strengthening reclamation standards.
- Conducting unannounced inspections.
- Including third-party monitoring with more inspections of high-risk mines such as cyanide heap leach operations.
- Requiring Notice-level operations to operate under the same regulations as larger mines.

Some groups said that BLM should be able to deny mining where it is not a suitable use of public lands, such as areas with important water, wildlife, scenic, or recreation resources. According to these groups, BLM should also deny mining where a mining company cannot demonstrate that a mine site can be reclaimed. Some groups also said that they will continue to work for comprehensive reform of the 1872 Mining Law.

Environmental Consequences

Alternative 1: No Action

Effects to miners of small operations and to communities would continue as they have in the past because mining regulations would not change. Miners on small operations would support this alternative because changes in regulations would not affect their current occupation or lifestyle.

Increasing numbers of people in the West and across the country believe that the surface management regulations should increase emphasis on protecting amenity resources. (See discussion under National Attitudes at the beginning of the Social Conditions section.) Alternative 1 is not consistent with these attitudes.

The environmental advocacy groups and many of the people associated with these groups would not support current management because they believe it does not sufficiently protect the resources on public lands. The condition of the resources on public lands is important to these people because they value these resources for recreation, wildlife, scenic and spiritual qualities, and a variety of other reasons. Many appreciate just knowing that these areas exist and would continue to exist in the future.

Alternative 2: State Management

Generally effects to miners of small operations and to communities would continue as they have in the past because mining under state regulation would be similar to current management. Miners on small operations would support this alternative because changes in regulations would not affect their current occupation or lifestyle. Mining-dependent communities may develop benefits based on the slight increase in overall mining.

Increasing numbers of people in the West and across the country believe that the surface management regulations should increase emphasis on protecting amenity resources. (See discussion under National Attitudes at the beginning of this section.) Alternative 2 is not consistent with these attitudes.

The environmental advocacy groups and many of the people associated with these groups would not support Alternative 2 because it would result in no federal regulation of locatable minerals mining on public lands. In the opinion of these groups, this alternative would result in insufficient protection of resources on public lands. In addition, BLM would be seen as abdicating its management responsibility. The condition of the resources on public lands is important to these people because they value these resources for recreation, wildlife, scenic and spiritual qualities, and a variety of other reasons. Many appreciate just knowing that these areas exist and would continue to exist in the future.

Alternative 3: Proposed Action

Under the Proposed Action activity by small operations (i.e. exploration, placer mining, and open pit mining) is estimated to decline by 10% to 30% because more operations would have to submit Notices or Plans of Operations and meet other requirements such as bonding. But the level of change that would actually occur is highly uncertain. Miners who could not continue in the mining business might find the search for satisfactory alternative employment to be difficult.

The stress of needing to change professions and possibly lifestyles has repeatedly surfaced as an important social problem. All people, through the socialization process, form a mental picture of "who they are." Groups of people such as loggers, ranchers, miners, and farmers tend to strongly identify themselves as belonging and being in a certain life role. It is extremely hard for them to imagine themselves "being" anything else (Lee and others 1991). This is especially true if the person has been engaged in a business and lifestyle for many years.

The effects to these miners might be mitigated by the fact that many rely on an array of skills and abilities, not just mining, to support themselves. Also, in the long run, the effects might lessen as miners become knowledgeable about the new regulations. Miners on small operations would oppose these changes because of concern about impacts to their occupation and lifestyle.

Under the Proposed Action the declines in mineral activity for large exploration, placer, and open pit mines could decline by 10% to 30%. The level of change that would actually occur is highly uncertain. All or some of the decrease would be due to forgone future mining rather than current operations shutting down.

In small isolated communities with a high degree of specialization in mining, the impact of a mine shutting down would be significant. The loss of well-paid jobs would result in outmigration, which would lower real estate values, the volume of local business activity, school enrollments, organizational membership, and community leadership. The tax burden might be increased or the level of services reduced for those who remain in the community.

These changes could occur at a time of increased demand for social services due to employment losses. The economic security and outlook of most of the resident population, as well as their level of social well-being would be adversely affected (Wenner 1992). Nevada communities would have the greatest potential for significant impact because of the potential effects to large open pit operations and their concentration in Nevada. Larger communities with a lesser degree of specialization in mining are less likely to be affected.

Increasing numbers of people in the West and across the country believe that the surface management regulations should have an increased emphasis on protecting amenity resources. (See discussion under National Attitudes at the beginning of this section.) Alternative 3 is consistent with these attitudes.

Under the Proposed Action the environmental advocacy groups who participated in scoping and many of the people associated with these groups would support this alternative because they would feel that wildlife and water resources are being more adequately protected. Some environmental advocacy groups, however, would feel that the problems they perceive with locatable mineral mining on public lands are going to be addressed only with the revision of the 1872 Mining Law. The condition of the resources on public lands is important to these people because they value these resources for recreation, wildlife, scenic and spiritual qualities, and a variety of other reasons. Many appreciate just knowing that these areas exist and would continue to exist in the future.

Alternative 4: Maximum Protection

Under the Maximum Protection Alternative mineral activity for small operations (i.e. exploration, placer, and open pit mines) would decline by 20% to 50%. Large operations would decline by an estimated 20% to 75%. All operations would have to submit Plans of Operations and meet bonding and reclamation requirements. The effects to persons and communities would be similar to those described for the Proposed Action, but much more severe.

Increasing numbers of people in the West and across the country believe that mining management should emphasize protecting amenity resources. (See discussion under National Attitudes at the beginning of this section.) Alternative 4 is consistent with these attitudes.

The environmental advocacy groups and many of the people associated with these groups would support Alternative 4 because they would feel wildlife and water resources are being more adequately protected. Some environmental advocacy groups, however, would feel that the problems they perceive with locatable minerals mining on public lands are going to be addressed only with the revision of the 1872 Mining Law. The condition of the resources on public lands is important to these people because they value these resources for recreation, wildlife, scenic and spiritual qualities, and a variety of other reasons. Many appreciate just knowing that these areas exist and would continue to exist in the future.

Alternative 5: NRC Recommendations

Activity by small operations (i.e. exploration, placer mining, and open pit mining) is estimated to decline by 0% to 10% under Alternative 5. For small miners who must find alternative employment, the effects would be the same as those described for Alternative 3. The effect is expected to be small and might lessen in the long term as miners become knowledgeable about the regulation changes. Miners on small operations may oppose these changes because of concern about impacts to their occupation and lifestyle.

Activity by large operations (i.e. exploration, placer mining, and open pit mining) is estimated to decline by 0% to 5%. Small rural communities are expected to lose only a few jobs relative to overall employment. All or some of this decrease might be due to forgone future mining rather than current operations shutting down. Little social impact to communities is expected under Alternative 5.

An increasing number of people in the West and across the country believe that the surface management regulations should have an increased emphasis on protecting amenity resources.

(See discussion under National Attitudes at the beginning of the Social Conditions sections.) Alternative 5 is consistent with these attitudes, but some people may feel that it does not go far enough to protect the environment.

Under Alternative 5, the environmental advocacy groups who participated in scoping and many of the people associated with these groups would feel that wildlife and water resources are not being protected well enough. The condition of the resources on public lands is important to these people because they value these resources for recreation, wildlife, scenic, and spiritual qualities, and a variety of other reasons. Many appreciate just knowing that these areas exist and would continue to exist in the future.

ECONOMIC CONDITIONS

Affected Environment

This analysis describes trends generally dating back to 1980 to include the entire period that surface mining regulations have been in effect, and also to include trends that are expected to affect the industry into the foreseeable future.

Mineral Production

Contribution of Western States to Domestic Mine Production. In 1998 mine production of nonfuel minerals in the United States totaled $39.6 billion. Currently the 12 western states in the study area contain 49% of the total land area in the United States (including all land ownership types) and contribute 40% of all nonfuel mineral production nationwide, $16 billion as of 1998. The portion of total domestic production originating from the western states has ranged from 38% in 1980 to 43% in 1990 (see Table 3-29).

Since 1990 the top three states in the United States in the value of mine production have been western states: Nevada, California, and Arizona. These three states alone, with 11% of the total U.S. land base, contribute 23% of the total value of domestic mine production of nonfuel minerals. Further, these three states possess 22% of the land base in the study area but contribute 57% of area's total value of mine production (see Table 3-29).

A closer look at production by commodity reveals that the western states contributed more than 96% of all domestic precious metals production (e.g. gold and silver), 99% of all copper mine production, and 47% of other base metals and locatable-type industrials combined. Overall, the study area contributed an estimated 69% of the Nation's total locatable-type nonfuel mineral production in 1998, or $11 billion. ("Locatable-type" minerals are the types of minerals that if found on public land would be considered locatable.) As these numbers show, the western states produce a disproportionate share of domestic mine production of locatable-type minerals. (See Table 3-30 and Figure 3-3.)

Not all of this production comes from BLM-administered public lands. It is difficult to determine the portion of total mine production of all locatable-type minerals originating from BLM-administered land for two reasons: mines are not required to report these figures, and many mining operations are on lands in mixed ownership (some combination of federal, state, or private lands).

Nevertheless, two recent reports estimate federal land production. These reports show that by commodity the portion mined from federal lands is highly variable (USDI 1993; GAO 1992). About 43% of gold mine production in the western states is estimated to come from federal lands, 1% of copper production, and 2% of industrial minerals overall.

Table 3-31 shows the portion of locatable-type minerals produced from federal lands based on these percentages. In total, about 10%, or $1.7 billion, of all locatable-type minerals combined are estimated to originate from federal lands. Most of this value is due to gold production, of which $1.4 billion is estimated to come from federal lands.

[Insert Figure 3-3 here]

Two factors may cause either an overestimate or underestimate of the value of mine production from BLM lands. First, these estimates include all federal ownership, not merely BLM-administered lands, which would overstate the value of mine production. Second, these estimates do not include mining facilities other than the mine itself and would tend to understate the value of production originating from BLM lands.

Although mine production figures for some base metals such as zinc, lead, and molybdenum were generally unavailable by state for confidentiality reasons, several western states are major producers of these minerals. The western states are also major producers of many locatable-type industrial minerals. Table 3-32 shows the national ranking of the western states for many locatable-type minerals. It shows, for example, Alaska first in domestic mine production of zinc, Arizona first in copper and molybdenum, Montana first in platinum group metals and talc, Nevada first in gold and silver, and Wyoming first in bentonite.

Appendix G contains maps of the United States showing the importance of the western states to metal mine production (see Figures G-1 through G-4). These maps also show that for nonmetallic minerals (industrial minerals) mine production across the United States is more evenly distributed than for metallic minerals.

Table 3-29. Value of Nonfuel Mineral Production 1980-1998 ($000)[1]				
State	**1980**	**1990**	**1998**	**Statewide Acreage**[2]
Alaska	$113,000	$577,000	$999,000	365,482,000
Arizona	2,430,000	3,065,000	2,770,000	72,688,000
California	1890,000	2,780,000	2,980,000	100,207,000
Colorado	1,260,000	386,000	650,000	66,486,000
Idaho	522,000	400,000	453,000	52,933,000
Montana	280,000	568,000	502,000	93,271,000
Nevada	386,000	2,611,000	3,170,000	70,264,000
New Mexico	765,000	1,098,000	888,000	77,766,000
Oregon	150,000	237,000	301,000	61,599,000
Utah	759,000	1,334,000	1,320,000	52,697,000
Washington	207,000	473,000	609,000	42,694,000
Wyoming	761,000	911,000	1,070,000	62,343,000
Study-Area Total	9,520,000	14,440,000	15,712,000	1,118,429,000
U.S. Total	$25,108,000	$33,319,000	$39,600,000	2,271,343,000
Study Area as Percent of U.S.	38%	43%	40%	49%

[1]Includes all nonfuel minerals, not all of which are “locatable-type” (such as sand and gravel, and other construction-type industrial minerals). Dollar figures rounded to three significant digits.
[2]Figures represent total statewide land area for all ownership types (federal and nonfederal).
Sources: Smith 1998; USBM 1982, 1992; BLM 2000.

Table 3-30: Estimated Value of "Locatable-type" Nonfuel Mineral Production,[1] Total Value of Nonfuel Mineral Production - 1998 ($000)						
State	**Gold**	**Silver**	**Copper**	**Other Metals & Industrials**[2]	**Total Value of Mine Production (Locatable-type Minerals)**	**Total Value of Mine Production (All Nonfuel Minerals)**[3]
Alaska	$174,000	$73,600	N/A[4]	$669,000	$916,000	$999,000
Arizona	17,400	34,700	2,060,000	381,000	2,493,000	2,770,000
California	177,000	1,860	0	816,000	995,000	2,980,000
Colorado	73,000	2,280	0	311,000	386,000	650,000
Idaho	53,000	73,200	N/A	243,000	369,000	453,000
Montana	77,900	12,600	82,000	280,000	453,000	502,000
Nevada	2,590,000	110,000	117,000	205,000	3,020,000	3,170,000
New Mexico	27,000	3,300	438,000	345,000	813,000	888,000
Oregon	0	0	0	83,800	83,800	301,000
Utah	110,000	19,100	488,000	451,000	1,070,000	1,320,000
Washington	33,600	102	0	155,000	189,000	609,000
Wyoming	0	0	0	219,000	219,000	1,070,000
Study-Area Total	3,330,000	331,000	3,190,000	4,160,000	11,000,000	15,700,000
U.S. Total	$3,480,000	339,000	$3,220,000	$8,920,000	$16,000,000	$39,600,000
Study Area as Percent of U.S. Total	96%	98%	99%	47%	69%	40%

[1] Includes gold, silver, copper, and other metals (platinum group, lead zinc, molybdenum, etc.). Also includes large variety of industrial minerals such as barite, bentonite, diatomite, gemstones, gypsum, limestone, perlite, pumice, silica stone, talc, vermiculite, etc. [2] Other Base Metals and Industrials exclude common clay, phosphate, potash, salt, sand, gravel, sodium, stone, and sulfur because these minerals are not “locatable” when found on public land. [3]For some states, figures for specific minerals reported by USGS were withheld to avoid disclosure of confidential data and appear in totals with other minerals. Consequently, for some minerals (e.g. copper), state production values were estimated from state reports and other sources. Some other withheld mineral values are contained in “Total Value of Mine Production.” [4] N/A means not available or not applicable.
Source: Smith 1998; USGS various years (b).

Table 3-31. Value of Locatable Mineral Production Originating from Federal Lands 1998 ($000)					
Portion of study-area production originating from public lands[1]	43.4%	36.2%	1.0%	2.4%	N/A
State	**Gold**	**Silver**	**Copper**	**Other Metals and Industrials**	**Total**
Alaska	$75,500	$26,600	$0	$16,100	$118,000
Arizona	7,550	12,600	20,600	9,140	49,900
California	76,800	673	0	19,600	97,100
Colorado	31,700	825	0	7,460	40,000
Idaho	23,000	26,500	0	5,830	55,300
Montana	33,800	4,560	820	6,710	45,900
Nevada	1,120,000	39,800	1,170	4,920	1,170,000
New Mexico	11,700	1,200	4,380	8,290	25,600
Oregon	0	0	0	2,010	2,010
Utah	47,700	6,910	4,880	10,800	70,300
Washington	14,600	37	0	3,730	18,300
Wyoming	0	0	0	5,240	5,240
Study-Area Total	1,440,000	120,000	31,900	99,800	1,700,000
U.S. Total (all land types)	$3,480,000	$339,000	$3,220,000	$8,920,000	$16,000,000
Federal Land Portion as Percent of U.S. Total	42%	35%	1%	1%	11%

[1]Source: USDI 1993.
N/A = not applicable. Figures rounded to three significant digits. Some totals may reflect rounding errors.
Note: Includes all production from federal lands, not just production from BLM-administered lands.

Table 3-32. Ranking of Western States by Mine Production of Mineral Commodities - 1998[1]						
	National Ranking					
State	#1	#2	#3	#4	#5	#6-#10
Alaska	Zinc	Lead Silver	Gold			
Arizona	Copper Molybdenum	Gemstones		Silver Zeolites	Pumice	
California	Asbestos Boron Diatomite Rare-earth metals	Feldspar Gold Magnesium Titanium	Perlite	Gemstones Pumice	Gypsum	Silver (8) Talc (6)
Colorado		Molybdenum			Lead	Gemstones (8) Gold (7) Zinc (6)
Idaho	Antimony Garnet		Lead Molybdenum Pumice Silver			Feldspar (6) Gold (8)
Montana	Platinum Palladium Talc		Bentonite Garnet	Lead	Copper Molybdenum Zinc	Gemstones (10) Gold (6) Silver (6)
Nevada	Barite Gold Lithium Magnesite Mercury Silver	Brucite Diatomite	Gemstones	Copper	Gypsum Perlite	Lime (7)
New Mexico	Perlite Zeolites	Pumice	Copper Mica			Gypsum (10) Molybdenum (6)
Oregon	Pumice		Diatomite Zeolites	Perlite	Gemstones	
Utah	Beryllium concentrates	Copper Magnesium metal	Magnesium compounds Mercury	Moloybdenum	Bentonite Gold Perlite Silver	
Washington			Magnesium metal	Diatomite		Gold (9)
Wyoming	Bentonite				Zeolites	

[1]Includes "locatable-type" minerals mined statewide regardless of surface ownership.
Sources: USGS 1998a; 1998b.

Trends in Mineral Production and Exploration

This section describes trends since 1980 and projections for future activity for the three main commodity groupings: precious metals, base metals, and industrial minerals. The projections are fairly general, given the diversity of mining on public lands: the wide variety of mining methods, commodities extracted, geographic scope, and inherent uncertainty of commodities markets.

These projections are based on historic trends in mining and current trends in commodity prices, exploration, and technological changes.

Precious Metals. Precious metals include gold, silver, and platinum group metals. As noted in Table 3-33, 88% of the $4 billion total value of precious metals mine production in the United States in 1998 was attributable to gold ($3.4 billion). Silver accounted for 9% ($339 million). And the platinum group metals (PGM) accounted for the other 3% ($136 million). Due to the overwhelming dominance of gold over other precious metals, the following analysis of trends in precious metals focuses on gold.

Table 3-33. Precious Metals Value of Production 1998 ($000)

Commodity	Value	Percent of Total Value
Gold	$3,480,000	88%
Silver	$339,000	9%
Platinum Metals Group	$136,000	3%
Total	$3,955,000	100%

Source: Smith 1998.

Production. Gold production in both the United States and worldwide has increased dramatically since 1980. In 1980, a total of 960,000 troy ounces was produced in the United States, accounting for 2.5% of worldwide production. By 1998, the United States produced a record 11.8 million troy ounces, accounting for more than 15% of worldwide production. Preliminary estimates for 1999 show that production has declined to 10.9 million troy ounces, but this is still higher than production in 1996 (see Figure 3-4).

More than 96% of current domestic production comes from the western United States, especially Nevada, which accounts for 75% of U.S. gold production. Four of the top five producing states are in the study area: Nevada, California, Alaska, and Utah, in that order. The U.S. Geological Survey estimates that gold is currently produced at 120 lode mines, a dozen or more large placer mines, and many smaller placer mines. Most of these placer operations are in Alaska. Of the domestic gold produced, the 30 largest mines yielded 92%, and 75 mines produced 98% of the total (Amey 1998). Of these top 30, a total of 27 are in the study area.

The most significant rate of increase in production occurred between 1984 and 1990, when gold production increased by an average annual 29% (from 2 million to 9.3 million troy ounces annually). Between 1992 and 1996, production was steady between 10.2 and 10.6 million troy ounces. The years 1997 and 1998 showed record production of 11.6 and 11.8 million troy ounces due to a significant amount of new capacity that had been in preparation during the previous 2 to 3 years before coming on-stream (Amey 1998).

[Insert Figure 3-4. U.S. Gold Production, 1980-1998]

Generally, gold mine closures are keeping pace with new gold mine openings and expansions in the United States At the same time the average output per mine has increased, resulting in a trend to fewer but larger U.S. gold mines. Most of the larger companies are replacing their annual production with new reserves, but smaller companies are finding this task more difficult (USGS 1998).

The United States is currently the world's second largest gold producer behind South Africa, which produced 19% of all gold in 1998 (down from more than half of total world production in 1980). Other significant producers are Australia (13%) (which ranks close behind the United States), Canada and China (7% each), and Russia and Indonesia (4% each).

The dramatic increase in gold production worldwide over the past 20 years is attributable to a variety of factors:

- Technological changes in gold mining methods such as the refinement of heap leaching techniques and the extraction of gold from refractory ores.
- Long-term sustained increases in gold prices following the end of government price and ownership controls in the 1970s.
- Increased demand for gold.
- Increased access to deposits outside the United States.
- A large sustained increase in exploration for new gold discoveries in response to these changes.

The worldwide gold reserve base has increased by 145%, from just over 1 billion troy ounces in 1980 to 2.3 billion troy ounces in 1998. The U.S. reserve base more than tripled over that period (from 60 million to 193 million troy ounces). As a result, the United States' share of the worldwide base increased from 6% to almost 8%.

Exploration. Exploration expenditures worldwide and in the United States continue to be dominated by gold. In 1998, 55% of all exploration expenditures for nonferrous metals were estimated to have been spent looking for gold (Amey 1998).

Exploration in the United States peaked in the 1980s but is still considered strong. Domestic exploration (for all nonferrous metals) as a percent of worldwide exploration expenditures decreased between 1992 and 1998 (from more than 21% to 8.6%), but spending on a total dollar basis for most of that period remained steady (Wilburn 1998; Mining Engineering 1999). According to preliminary estimates for exploration spending in 1999, spending in the United States increased to about 10% of worldwide expenditures for nonferrous metals. On a total dollar basis, expenditures dropped to $216 million in 1999 from $243 million in 1998 (Mining Engineering 1999). Much of the domestic exploration for gold is aimed at replacing annual production at existing operations with new reserves rather than focusing on new discoveries.

In recent years the focus has shifted to other regions of the world, such as Latin America, Asia and the Pacific, and Africa. Many countries have revised their mining laws, are offering incentives for foreign investment, and in some cases have opened up areas previously closed to exploration. The transformation of centrally planned economies to market-based economies has also made deposits in these countries more attractive as investment opportunities (Amey 1997).

In addition to the "pull" of other countries as exploration targets due to economic and political reforms, there is also the view that permitting and environmental requirements in the United States are increasing costs and permitting times and thus are "pushing" exploration out of the U.S. (Dobra 1997; Fraser Institute 1998; Wilburn 1998).

Conversely, a recent study of the gold industry found that the U.S. is a relatively low-cost producer: "...[T]he world's largest producers other than the U.S., namely, South Africa and Australia, have the highest costs. U.S. producers, on the other hand, are the second lowest cost producers next to Brazilian producers, whose costs are very similar," (Dobra 1999).

Additionally, internationally recognized environmental standards are increasingly being required to secure funding for mining projects regardless of location (White 1997). These requirements would tend to offset to some extent the potential cost advantage of fewer permitting and environmental requirements.

Further, as noted in a recent study of the revival of the domestic copper industry in the 1980s, for the metal mining industry to succeed in the current economic environment, firms must constantly pursue new technologies and productivity gains (Tilton and Landsberg 1997) irrespective of permitting and environmental requirements of the host country. This quest has created a highly competitive global mining industry. Thus, the net effect of these factors on United States production is difficult to ascertain.

Prices. Gold prices play a significant role in the exploration and development of gold deposits. Between 1974–when the last of government price controls and restrictions on gold trading were abolished–and 1996 prices steadily and sometimes dramatically increased, peaking in 1980 at an average annual price of $613 (see Figure 3-5). From the late 1980s to 1996 the average annual price fluctuated within a relatively close range of $340 to $390 per troy ounce. But since the latter part of 1996 the price has trended downward rather significantly, hovering in the range of $280 to $300 since then.

The recent downward trend has been mainly attributed to the following: central bank sales; speculative selling; producer hedging; fears of future sales by central banks; and economic turmoil in Southeast Asia, Russia, and, more recently, Latin America.

Global economic conditions are now showing signs of improvement, especially in Southeast Asia. The downward pressure on gold prices has occurred despite evidence of strong worldwide demand for gold, at least through 1998 (Murray 1998). Demand in 1999 appears to have declined due to lower demand for jewelry although demand increased for gold in coins and electronics.

Demand so far in 2000 appears to be strong (World Gold Council 2000). The near-term outlook is for an increased demand for fabricated gold and for the price to average about $280/oz (Gold Fields Mineral Services 2000). But continued apprehension about global economic conditions combined with recent gold market conditions makes the longer term outlook highly uncertain for gold prices and the market.

[Insert Figure 3-5. Average Gold Prices, 1980-1999]

Projections. The gold market has a great deal of uncertainty, which has persisted since about 1996. Demand for gold has been strong in recent years (Gentry 1998) but not in all sectors. Demand for gold for jewelry fabrication, which accounts for about 75% of all gold demand, fell in 1999, and increased demand in other sectors did not completely compensate for that drop (Gold Fields Mineral Services 2000). Thus, overall worldwide fabrication fell about 1.4%. Improved international economic conditions are expected to contribute to an increase in demand of about 3.6%, at least during 2000 (Gold Fields Mineral Services 2000). Contributing to this demand will be population growth around the world, increased standards of living in many developing countries, and generally improving international economic conditions.

Beyond 2000, the situation is less clear. U.S. and worldwide exploration expenditures are expected to continue at lower levels than in the past due to low commodity prices. As less gold is discovered and old gold mines are closed, a gap may be created between the world's future gold supply and its demand, thereby creating excess demand (Amey 1998). This in turn could cause the price of gold to increase.

The globalization of mining opportunities has opened to exploration and development many areas that had previously been closed. Thus, worldwide supply of minerals such as gold are expected to increasingly originate from countries other than the United States. Nevertheless, interest in exploration in the western United States, especially Nevada, is expected to remain strong (Gentry 1998). The World Gold Council expects that future gold production will increase at a slower rate in the future than during the 1980s and 1990s, at 1.3% to 3% per year, in contrast to annual growth rates of over 4% for the past 17 years and growth rates in the 1980s exceeding 6% (Kral 1997).

Given the recent trend in steady domestic gold production, the dramatic increase in production opportunities outside the United States, worldwide demand for gold, the anticipated rate of growth in supply, and high level of uncertainty of gold prices and other market conditions, annual domestic production is expected to remain steady or slightly decrease for the foreseeable future. Further, the western United States, especially Nevada, is expected to remain the dominant region for production. Most of the existing large mines are expected to continue operating as depleted reserves are replaced. But lower exploration expenditures in the U.S. and worldwide may result in fewer mines being development in the future.

This scenario assumes that gold prices stabilize in the range observed over the recent past. An extended period of low gold prices, such as that experienced since 1996, or prices that drop even lower for a sustained period, may reduce gold production in the future. Lower prices tend to hit exploration first–this has already occurred both in the U.S. and worldwide–as well as smaller, high-cost producers. Some mines may close earlier as higher graded, lower cost ores are extracted and are not replaced by new reserves. But most of the larger, newer, low-cost producers are expected to withstand current gold market conditions. Conversely, a sustained significant increase in price would spur more exploration for new ore bodies and encourage extraction of lower grade ores at existing mines, thereby extending the life of many of these mines.

Up to 43% of total domestic production comes from public lands (including BLM and Forest Service lands). But a substantial portion of existing mines are awaiting patent approvals that would move them from public to private ownership. This patenting will decrease the portion of total domestic production from public lands in the foreseeable future. In the longer term, however, if public lands become permanently closed to patenting (a congressional moratorium exists on new patent applications), the portion of domestic gold production on public lands would likely begin to increase once again.

Pending Plans of Operations for exploration or development have been factored into these projections. Most of the current pending Plans are for precious metals exploration or development, and most of these are for expanding existing operations.

Base Metals. The base metals category includes a variety of minerals such as copper, lead, zinc, iron ore, molybdenum, and nickel. The base metals with the greatest production in the western United States are copper, lead, molybdenum, and zinc. As noted in Table 3-34, 65% of the $5 billion total value of U.S. production of the major base metals in 1998 was attributed to copper ($3.2 billion). Zinc accounted for 16% ($819 million), lead 10% ($480 million), and molybdenum 9% ($456 million). Because of the dominance of copper over other base metals, the analysis of trends in base metals will focus on copper. The copper trends are meant to generally represent trends for the other base metals as well.

Table 3-34. Base Metals Value of Production 1998 ($000)

Commodity	Value	Percent of Total Value
Copper	$3,220,000	65%
Lead	$480,000	10%
Molybdenum[1]	$456,000	9%
Zinc	$819,000	16%
Total	$4,980,000	100%

[1]Figure for molybdenum is production value for 1996 since values for later years have been withheld to avoid disclosing company proprietary data.
Source: Smith 1998.

Copper Production. Between 1980 and 1998 copper production in the United States increased by more than 60%, from 1.2 million to 1.9 million metric tons annually (Figure 3-6). U.S. production accounted for 15% of worldwide production in 1998, about the same as its worldwide contribution in 1980 (and down from its 19% share in 1994). Domestic production, though increasing during the 1990s to record levels through 1997, decreased in1998 by about 4% to its lowest level since 1995 due to overcapacity and lower copper prices. Preliminary estimates for 1999 show continued decline in domestic mine production to about 1.6 million metric tons (USGS 2000).

Five western states accounted for virtually all (99.6%) domestic copper mine production in 1998. In descending order these states are Arizona (67% of all domestic production), Utah, New Mexico, Nevada, and Montana. Although copper was extracted from 38 mines, 15 mines accounted for 98% of all domestic production in 1998 (Edelstein 1998). In 1980, by contrast, 25 mines yielded 96% of all domestic production (USBM 1981). These statistics show that, like gold mines, copper mines tend to be decreasing in number but increasing in output.

Copper is mined in about 50 countries. With 15% of world production, the United States is the world's second largest mine producer behind Chile, which accounted for 30% of the 1998 worldwide production. Other major producers include Indonesia, Canada, and Australia. In total, the top 10 countries account for about 82% of worldwide production.

World production continued to increase to record levels, to 12.2 million metric tons in 1998. The bulk of increased production worldwide came from Chile, where mine production has increased by 85% since 1993 (Edelstein 1998) and where U.S. companies continued to invest heavily to expand production and reduce costs. In the mid-1990s, most U.S. copper mining companies reported record profits from copper operations owing to high production levels, lowered operating costs, and record-high copper prices. But declining copper prices beginning in 1997 have caused a large decrease in the total value of production and the closure of several mines (Edelstein 1998).

The worldwide copper reserve base has increased by 29%, from 505 million metric tons in 1980 to 650 million metric tons in 1998. But the U.S. reserve base has remained unchanged since 1980 at about 90 million metric tons. Consequently, as a portion of the worldwide base, the U.S. share has declined from 18% to about 13%. Most of the increase in the reserve base is due to new deposits discovered in Latin America, especially Chile (USBM and USGS various years).

[Insert Figure 3-6. U.S. Copper Production, 1980-1998]

Exploration. Preliminary data on exploration shows that exploration budgets for base metals in 1999 will make up about 37% of worldwide exploration expenditures, or $800 million, as reported by the Metals Economics Group (Wilburn 2000). Though this is a higher percentage than reported in 1997 and 1998 (27% and 33% respectively), on a total dollar basis, exploration expenditures are declining. Copper was the dominant target, comprising about 58% of all base metal expenditures (Wilburn 2000). The reduced level of exploration reflects lower prices and a continued oversupply of copper. Copper exploration in the United States is still centered in the West.

Projections. Beginning about mid-1997, new copper mining capacity coming online worldwide outstripped the growth in demand for copper that caused price declines and the closing of several large mines in the U.S. (mainly in Arizona and Nevada) and in other countries as well (Edelstein 2000; Silva 2000). There are indications that the demand-supply balance is improving, and this improvement should stabilize the industry for the near future. But conditions in the industry over the past few years and the closing of several U.S. operations are likely to result in little or no growth in copper mine capacity for the next few years.

Currently only 1% of domestic copper is mined on federal land, including land managed by BLM and other federal agencies, This is a much smaller percentage than is estimated for gold production on federal land (USDI 1993). This situation is also expected to continue because there is currently little exploration, and no Plans of Operations for copper are pending for public lands in Arizona, the dominant copper producing state (Kershaw 2000). New Mexico has only one pending Plan of Operations for copper mining, which is for expanding a mine (Dalness 2000).

Industrial Minerals. The industrial minerals category includes a wide variety of minerals with a great diversity of end uses. This category includes mainly all the nonfuel minerals not included as precious or base metals. Industrial minerals can generally be broken into subcategories related to their end uses. Many minerals, however, fit into more than one subcategory. For example, the *construction* subcategory includes minerals such as crushed stone, sand and gravel, pumice, gypsum, limestone, and some clays. Other subcategories include the following:

- *Chemical* (e.g. salt, lithium, iodine, bromine, strontium, and lime).
- *Agricultural* (e.g. potash, phosphate rock, sulphur).
- *Abrasives* (e.g. pumice, silica sand).
- *Fillers and extenders* (e.g. talc, mica, kaolin clay, graphite).
- A *miscellaneous* subcategory (including some high-value minerals such as titanium and rare earths).

Not all industrial minerals are locatable if found on public land. Examples of locatable industrial minerals include barite, bentonite, diatomite, feldspar, gemstones, gypsum, magnesium compounds, perlite, pumice, silica stone, talc, and vermiculite. Many other industrial minerals are considered either leasable or saleable: sand and gravel, common clays, crushed stone, some limestones, phosphate, potash, sodium (including soda ash), and sulfur. Leasable and saleable minerals are not locatable and are not included in this analysis or rulemaking.

The estimated value of locatable-type industrial mineral mine production attributable to the EIS study area was $2.4 billion in 1998. This estimate was derived from Table 3-30, which appears earlier in this chapter. Table 3-30 shows that "Other Metals and Industrials" totaled $4.2 billion in mine production value. But $1.8 billion of that amount can be attributed to base metals such as lead, molybdenum, and zinc. The remaining $2.4 billion can be attributed mainly to industrial minerals.

The large number of commodities in the industrial minerals category makes it difficult to assess the general trends in exploration and production for each mineral. It is also difficult to assess the general trends for the category of industrial minerals as a whole given the wide variety of end uses.

Nevertheless, an increase is expected in exploration and development of industrial minerals on western public lands in the foreseeable future for several reasons. First, the general overall growth in the domestic economy (and internationally) is fueling an increased demand for most of the end uses to which industrials are put. Second, many deposits of industrials previously on public land have already been transferred to private ownership through the patenting process. Therefore, future operations are expected to increasingly originate from public lands, assuming continuation of the congressional moratorium on new patenting. And third, generally speaking, many industrials are mined relatively close to where increases in economic activity and population growth are greatest, and many western states are experiencing rapid economic and population growth.

According to a 1993 Department of the Interior study, industrial minerals with more than 10% of total domestic production from federal lands (including federal lands *not* managed by BLM) include diatomite 53%, fullers earth 11%, gemstones 50%, pumice 14%, silica stone 25%, and talc 42% (USDI 1993).

Currently several Plans of Operations are pending for industrial minerals, mainly for gypsum, limestone, silica sand, and cinder mines.

Strategic and Critical Materials. Strategic and critical minerals are those in which the United States is deficient or domestic sources are insufficiently developed to supply the military, industrial, and essential civilian needs of the United States for national defense. To reduce dependence on foreign sources in times of national emergency, Congress established the National Defense Stockpile (NDS) of strategic and critical minerals. Many of the minerals on the strategic and critical list are locatable-type minerals. Inventory of only a few of the minerals on the list, however, is lower than National Defense Stockpile goals, for example, cobalt, graphite, some gemstones, mica, and platinum group metals.

In recent years, the Defense National Stockpile Center, which operates as an international commodity broker of strategic and critical minerals for the U.S. Government, has been liquidating much of the stockpile, and the goals for maintaining inventory for many minerals have been eliminated, although the list remains (U.S. Department of Defense, Defense Logistics Agency 1997; Mory 1998). Figure 3-7 shows the level of annual sales from and acquisitions to the stockpile.

[Insert Figure 3-7. National Defense Stockpile Sales and Acquisitions, 1991-1999]

Contribution of Mining to the Regional and National Economy

The mining industry for locatable-type minerals is an important contributor to the economies of the western states, to the national economy, and especially to some counties in the study area with significant mining. The contribution to these economies can be measured in several ways:

- Value of mineral production (see previous section).
- Contribution to each state's gross state product and to national gross domestic product.
- Level of employment and personal income directly attributable to the mining industry.
- Number of mines.
- The multiplier effects, which estimate the indirect and induced economic effects of mining in addition to direct effects.
- Role of mining in the economies of mineral-rich rural communities.

The following section describes the economic contribution of locatable mine production *overall* for the study area (except where noted), not merely the portion from public lands. Locatable minerals production on public lands contributes an estimated 10% of the study area's total value of mine production overall, but this percentage varies by commodity.

Mining for metals and nonmetallic minerals in the study area collectively contributed $7.5

billion to the *gross state product* (GSP) in 1997, the latest year for which GSP data are available (BEA 1999). GSP is a state's sum of each of its industries' gross output less intermediate goods and services purchased from other industries or imported, also referred to as "value added." This $7.5 billion represents 0.5% of the study area's combined GSP of $1.62 trillion.

More significantly, however, the study area contributed 44% of the Nation's total gross domestic product (GDP) for the metals and nonmetallic minerals mining sectors combined. For the metals-mining sector alone, the study area contributed 74% of the Nation's total GDP (see Table G-1 in Appendix G). Gross domestic product is the sum of the GSPs for the 50 states.

Trends in mining's contribution to GSP since 1982 are uneven among the western states. (Note: Due to new indexing techniques used for estimating inflation-adjusted changes in gross domestic product and gross state product, 1982 is a more suitable base year for this trend analysis than 1980, which is the base year used for other statistics in this section.) For metals, most states increased their contributions to GSP between 1982 and 1997, as measured in 1992 chained dollars. But the contributions of two states–Colorado and Wyoming–declined.

Of the states showing increases, the change varied from a 33% increase in contribution to GSP in New Mexico to a 5,100% increase in Alaska. But on a total dollar basis, the largest increase in contribution to a state's GSP came in Nevada, where metal mining increased by $1.4 billion, from $199 million to $1.6 billion.

For nonmetals all states showed increases in the contribution to each state's GSP. Increases ranged from 5% in Nevada to 233% in Arizona. On a total dollar basis, California showed the largest increase, from $378 million in 1982 to $947 million in 1997, a $569 million increase. It is difficult to tell how much of the nonmetals category is attributed to locatable-type minerals. The nonmetal category in GSP includes many minerals, such as sand and gravel and many other construction-type minerals, that are not locatable and are not covered by this rulemaking. Many of these minerals are mined near construction sites. Because the West has been experiencing record population growth, much of the increase can be attributed to these construction minerals.

On the whole, the western states showed a 172% increase in metal and nonmetallic mining's contribution to GSP, from $2.8 billion in 1982 to just over $7.5 billion in 1997, as measured in 1992 chained dollars. This increase is the combined result of a 212% increase in metals and a 127% increase in nonmetals. During the same period, the combined GSP of the region increased by 69% overall. The net result is that the contribution of metals and nonmetals in the western states, *as a portion of the region's total GSP,* increased from 0.3% in 1982 to 0.5% in 1997.

Another measure of the contribution of locatable-type mining is in *personal income and employment*. This information is collected in detail by state and reported nationally by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). The study area's direct contribution of the metals and nonmetallic minerals mining industries was $3.3 billion in personal income (Table G-2 in Appendix G) and 67,000 jobs in 1998, the latest year for which data are available. This amount represents about 2% of the study area's total personal income and employment, which is proportionately greater than these sectors' contribution to area GSP.

Total personal income nationally for metals and nonmetal mining combined was $8.2 billion in 1998. The study area's contribution of $3.3 billion represents 40% of these sectors nationally.

The Bureau of Labor Statistics (BLS) also reports employment levels and trends. BLS figures do not match BEA figures due to differences in data collection. Although BEA and BLS employment figures don't match in absolute numbers, these two data sets do show similar *trends* for levels of mining employment and mining's share of total employment, both at the state and national level.

During the 19-year period from 1980 through 1998, BLS data show that metal mining employment in the study area declined by 44 %, from 65,000 to 36,000 jobs. This amount tracks the national trend, which showed a 51% decline over the same period. Employment in nonmetallics declined by 17% in the study area, compared to an 11% decline nationwide. At the same time, overall employment in the study area increased by 54% (Bell 2000). This decline shows that mining employment has become a smaller portion of total employment over the past 19 years, even while mine production has increased significantly over that period (see Table G-3 in Appendix G).

There are exceptions to these trends. The most obvious counter-trend has occurred in Nevada, where metal mining employment increased by 216% from 3,600 jobs in 1980 to 11,500 by 1998. Nevada currently contributes nearly a third of all metal mine employment in the study area, virtually all related to gold mining. (Nevada and Arizona combined contribute 61% of all metal mining employment. Arizona's employment is attributed mostly to copper mining.)

Alaska also shows a significant increase of 294% in metal mining employment, but the state overall contributes only 3% of all current metal mining employment in the study area. In nonmetallic mineral production, Arizona, Colorado, and Washington showed significant increases (60%, 110%, and 47% respectively). Many nonmetallic minerals are not considered locatable minerals on public lands.

While overall trends in employment and income in the metal and nonmetallic mineral mining industries show declines, these trends alone would tend to understate the importance of these sectors to the economies of the western states and the Nation as a whole. These employment and personal income figures represent the *direct* impact the metal and nonmetallic mining sectors have on the regional and national economies.

In addition to direct employment and income effects, these industries purchase capital equipment for mine development, buy operating supplies and business services, and hire workers who in turn spend their incomes on goods and services. These added spending levels create a *multiplier effect,* which accounts for indirect and induced effects as well as direct effects. The sum of direct, indirect, and induced effects is the multiplier effect, or total economic impact.

The IMPLAN input-output modeling system was used to estimate the total economic impact of locatable mineral production on public lands in the study area for 1998 mine production. (These impacts are based on the 10% of the total value of mine production estimated to originate from federal lands.) The $1.7 billion in production value is estimated to have contributed the following:

- $3.1 billion dollars in *total industry output*.
- $1.4 billion in *total income* (of which $766 million is employee compensation).
- $1.6 billion in *value-added*.
- 21,310 *jobs* overall to the study area (see Table 3-35).

The greatest impact is from mining in Nevada, where 59% of all total industry output and half of all jobs are located. Nevada's dominance is due to its large amount of gold produced from federal land.

Total industry output measures the total economic impact of purchases (e.g. capital equipment purchases and operating expenditures) within the study area by the mining industry to mine locatable minerals in 1998.

Total income impacts translate the impact of changes in expenditures by the mining industry into changes in income. Income includes employee compensation, proprietary income, and other property income. Employee compensation, as a subset of total income, represents total worker income generated by mining industry expenditures.

Employment impacts represent the total number of jobs generated by final demand expenditures by the mining industry in the study area, as measured by both full- and part-time jobs. Appendix G, Methodology for Estimating Contribution of "Locatable-Type" Mineral Production on the Economies of the 12 Western States, explains how these estimates were derived using the IMPLAN input-output model.

Table 3-35: Estimated Regional Impacts from Production of Locatable Minerals on Public Lands 1998 ($000)

State	Total industry Output	Personal Income		Value Added	Employment (jobs)
		Total	Employee Compensation		
Alaska	$144,000	$65,900	$30,500	$83,800	970
Arizona	$40,600	$20,500	$12,200	$24,100	320
California	$142,000	$76,500	$46,500	$83,800	1,020
Colorado	$57,600	$28,400	$16,300	$33,800	350
Idaho	$69,400	$35,300	$20,700	$41,800	680
Montana	$61,700	$29,300	$18,200	$37,600	410
Nevada	$1,810,000	$830,000	$466,000	$908,000	10,740
New Mexico	$32,000	$12,000	$5,500	$16,600	220
Oregon	$1,250	$500	$900	$1,000	10
Utah	$49,200	$20,900	$11,100	$25,700	360
Washington	$19,900	$11,900	$7,600	$13,300	130

Wyoming	$3,500	$1,800	$900	$2,500	30
12-State	$3,080,000	$1,390,00	$766,000	$1,590,00	21,310
Note: These estimates include *only* production estimated to originate from federal lands. Figures rounded to three significant digits. Source: IMPLAN Input-Output Modeling System (see Appendix G).					

A variety of other recently completed studies have measured the economic impact of the mining industry. One study, *The U.S. Gold Industry 1998,* found that in 1997 gold and silver production nationwide contributed $7.7 billion in output, $2.3 billion in earnings, and nearly 84,000 jobs (Dobra 1999). The study notes that most of this impact is due to mine production from the western states.

This study and the IMPLAN impacts mentioned above use different models and thus produce different results. The Dobra study focuses on gold and silver and includes all land ownership types. The IMPLAN analysis in this EIS includes most locatable minerals and only the portion estimated to be mined from public lands.

A similarity of these two results is that measuring the multiplier effect state by state misses the economic impact that a mining company makes in states outside the area modeled, a limitation noted in *The U.S. Gold Industry 1996* (Dobra 1997). For example, capital equipment purchases by a mining company in Nevada from a firm in Illinois would not show up as an injection into the Illinois economy unless Illinois were part of the study area modeled. Consequently, some economic contributions from mining investment are understated at the national level. This understatement is not unique to mining impacts, however. Assessing the economic impact of one sector within a state on that state's economy is subject to this limitation.

Another study, published by the National Mining Association, estimated the economic impact of the solid-minerals mining industry (Leaming 1997). This study, which includes minerals such as coal and many nonlocatable types, estimated that the western states generated $115 billion and 1.1 million jobs in 1995, or 37% of the total U.S. impact of solid-mineral mining of $524 billion and 22% of the estimated 5 million total jobs. The data and methodology used in this study differ substantially from the multiplier analyses described previously. The figures from the two studies cannot be compared, but the Leaming (1997) study provides a useful comparison of the western mining industry in relation to the national industry.

Mining is also important to many rural communities and counties in ways that are not captured by looking strictly at its contribution to the state or regional economy. Many western counties have significant amounts of locatable mining. This mining contributes a disproportionate share of local employment and income in relation to the industry's contribution statewide.

One way to measure this contribution is by using a "location quotient." A location quotient is simply a ratio of a county's percent employment in a particular industry to the statewide percent employment in that industry (USFS and BLM 1998). A location quotient greater than 1 shows that the county is specialized in that industry. The greater the quotient exceeds 1, the greater the degree of specialization.

Using standard Bureau of Economic Analysis (BEA) employment data, one can determine location quotients only for the mining sector as a whole because employment data is not reported in greater detail as, for example, for metal mining. But estimating location quotients using BEA personal income data rather than employment data does allow for greater industry detail. For this reason, BEA personal income data is used in this analysis rather than employment data to show why the level of specialization in metal and nonmetallic mining for counties in the study area can be an important issue.

The area encompassing the Carlin Trend in Nevada gives a good example of how important mining can be to local economies. Mining in the Carlin Trend area most immediately affects Elko and Eureka counties. In this area most of the metal mines are in Eureka County, but most mine employees live in Elko County. (Other mines in these two counties but not on the Carlin Trend are also included in the analysis.)

In 1998 metal mining contributed $324 million personal income to the area, about 29% of the area's total personal income of $1.1 billion. In contrast, metal mining provided 1.4% of total personal income statewide ($705 million of the state's total personal income of $50.9 billion). The location quotient for employment in the Elko-Eureka counties area, then, is 21 (29% divided by 1.4%), showing a high degree of mining specialization for the area.

Further evidence of the importance of mining to this area (and other western rural areas whose mining employment has grown) is the rate of growth since 1980. In 1980 personal income for mining overall (data was unavailable for metal mining) represented 10% of all income for the two-county area. With mining contributing 1.8% to statewide employment during that time, Elko and Eureka counties had a combined location quotient of 5.7 in 1980. So at a time when the statewide and westwide economies have been growing more diversified, the Elko-Eureka counties area has become more dependent on mining.

BLM recognizes that other counties in the western U.S., not just the Elko-Eureka counties area, would also have location quotients much greater than 1, showing a high degree of specialization in mining. Also, counties not currently specialized in mining could become so in the future if mines were to be developed there. The Elko-Eureka counties example is presented simply to show how location quotients can be used.

Description of Mining Operations

The wide variety of mining and milling methods depends on the type of mineral mined and physical properties of the deposit. Representing all of these variations in one programmatic study is not practical. Appendix E describes seven "typical" operations for exploration and placer, open pit, underground, and strip mining. These descriptions are not meant to represent an entire industry using a particular method but instead are meant to represent "typical" operations that could reasonably be expected on public lands. Also, exploration, placer, open pit, and strip operations are the most common types of mining for locatable minerals on public lands.

These models describe the mining method, mineral deposit, size of operation, mine life, and other characteristics. The purpose of the models is to further describe how operations might be affected and the costs they might result from the proposed regulation changes and alternatives.

Use and Nonuse Values

In addition to economic activity of public lands mining, the value of nonmining environmental resources, amenities, and uses is also important. The types of resources and amenities that could be considered in an economic impact analysis of mining regulations could be extensive. For example, impacts to the following all have economic implications: fish and wildlife populations, habitat, water quantity and quality, recreation, scenic quality, endangered species, ecosystem functions, biodiversity, and air quality.

Most of these resources have more than one type of value, generally called "use" and "nonuse" values. Use value refers generally to consumption value, for example, the economic value (e.g. expenses) of hunting elk or hiking in a wilderness area. Nonuse value is independent of use. Nonuse values might consist of the value one may place on preserving a population of endangered species or on preserving a scenic view for future generations (Freeman 1993).

Use values are generally observed through the activities of markets where prices are set for goods and services. Nonuse values can be defined "... as an individual's willingness to pay to preserve or maintain a resource..." beyond what he has already paid for that resource in the market (Freeman 1993). For environmental resources and amenities, markets in many cases do not exist or are not well defined. Consequently, use and nonuse values are difficult to determine.

Wildlife-related recreation serves as one good example of the value of environmental resources and amenities. A recent survey by the U.S. Fish and Wildlife Service estimated that expenditures for hunting, fishing, and wildlife viewing in 1996 totaled nearly $9 billion in the study area (FWS and Bureau of the Census 1997). Expenditures include lodging, transportation, and eating expenses; purchases of hunting and fishing equipment; binoculars; and a wide variety of other expenses. Expenditures by state are listed in Table 3-36.

Table 3-36. Expenditures for Wildlife-Related Recreation in Study Area 1996 ($000)

Alaska	$ 781,000	Nevada	$ 263,000
Arizona	1,029,000	New Mexico	429,000
California	2,397,000	Oregon	693,000
Colorado	792,000	Utah	237,000
Idaho	146,000	Washington	1,661,000
Montana	219,000	Wyoming	235,000
TOTAL			$ 8,882,000

Note: These values include all lands within the states in the study area and are not intended to represent values only for BLM-administered lands.
Source: FWS and Bureau of the Census 1997.

These recreation expenditures are one example of use value for fish and wildlife. Other use values that should be considered for fish and wildlife include commercial production such as commercial fisheries, and subsistence value–the value to American Indians of fish and wildlife for noncommerical uses (Flather and Hoekstra 1989; BLM 1988b).

Nonuse values, which are independent of expenditures, take various forms:

- Option value–the value a person places on a resource to preserve it for possible future use.
- Existence value–the value a resource has even though the person will never use it.
- Bequest value–the value a person places on a resource to preserve it for future generations.

The sum of use value and all nonuse values for a particular resource is that resource's total value (Freeman 1993).

Recognizing both use and nonuse values for environmental resources is important. But quantifying these values for all the nonmining resources in this EIS would be difficult at best for several reasons:

- Data for many resources either do not exist or exist only for site-specific areas.
- The number of resources and amenities to consider is large.
- The study area is large.
- "Markets" do not exist for many of these resources, and their values are virtually impossible to determine (as, for example, a plant or insect that may have no apparent current value, but for which a valuable use may be discovered in the future).

But the EIS does consider the impacts of the regulations and alternatives to environmental conditions for a wide variety of resources. In that sense, this EIS does portray the *tradeoffs* between mineral activity and environmental conditions across the alternatives.

Environmental Consequences

Introduction

Appendix E details the analysis used to estimate changes in overall mining activity for each of the alternatives. Additionally, it provides mine cost models detailing how each of the five alternatives might affect the cost structures and requirements for seven typical mining operations. These scenarios are hypothetical and are given for descriptive purposes only. They are not meant to portray any particular mining operation or any specific state's permitting process. They should be viewed as simply illustrative of changes a mining operation might experience under these alternatives.

Alternative 1: No Action

The No Action Alternative is not expected to have any overall effects on trends in mineral exploration and development as described in the previous section. Over the long term, exploration for and development of precious metals, particularly gold, are expected either to continue at levels of the recent past or to slightly decrease. This projection reflects the following:

- Recent trend in steady domestic gold production.
- Dramatic increase in production opportunities outside the United States.
- Worldwide demand for gold.

- Anticipated rate of growth in supply.
- High level of uncertainty of gold prices and other market conditions.

This projection assumes that the price of gold stabilizes in the range observed over the recent past.

But the current gold market is characterized by low prices (which have persisted for about 2 years) relative to the past 20 years, coupled with lower than expected demand from Southeast Asia due to that region's economic problems. Consequently, the short-term outlook for gold production remains uncertain.

For base metals, particularly copper, there is likely to be little or no growth in mine capacity for the next few years. For production of industrial minerals, the western United States will likely see an increase in activity overall on all types of land ownerships including public lands. The overall projections in production of precious, base, and industrial minerals are based on trends in those commodity markets and do not necessarily coincide with the expected number of future Notices and Plans of Operations.

Alternative 2: State Management

Overall and over the long term, mineral activity could increase up to 5% from current levels across the study area after the State Management Alternative is fully implemented. Changes in performance standards and environmental review for some states would be the primary drivers of increased activity for most types of small operations (e.g. exploration, placer, open pit, and underground) as well as for large underground and for most industrial mineral mining.

But because states would have discretion on when and how to apply performance standards, it would be difficult to specifically describe the impacts from exercising this discretion. For larger operations (especially exploration, placer, and open pit) changes in administrative requirements and changes in performance standards would be more evenly split in their impacts on operations.

Under Alternative 2 BLM would neither review nor approve any specific project because the states would regulate mineral activities on BLM-administered lands. Administrative elements likely to have the greatest effect are the content and processing requirements for Notices and Plans of Operations and the 5-acre threshold for Plans of Operations, since BLM would no longer require Notices and Plans. Time delays due to preparing EISs would be reduced or eliminated in most states. But California, Montana, and Washington have state laws similar to the federal National Environmental Policy Act (NEPA), under which EISs would still be prepared. In these three states there would likely be little time advantage to implementing this alternative.

Assuming a 5% increase in mining, the value of mine production of locatable minerals would increase up to an estimated $85 million across the study area. This level of increased production would contribute up to 1,070 more jobs to the region, $154 million more in total industry output, $70 million more in total personal income (of which $38 million would be employee compensation), and $79 million more in value-added.

Table 3-37 shows the regional economic impacts by state and for the study area overall. For the study area's total current value-added as measured by gross state product (GSP), this amount represents a 1% increase in the metals and nonmetallic sectors. Most states would likely see increased levels of activity on public lands. But on the basis of the current level of production, Nevada is estimated to produce the largest increase ($90 million in industry output), more than half the gain for the study area as a whole.

These economic impacts assume an increase of up to 5% in activity overall. States, such as California, Montana, and Washington, that have National Environmental Policy Act-type review provisions might not realize an increase because there would likely be no time advantage for this alternative. Also, some states have environmental protection regulations similar enough to the 3809 regulations that mining might not realize significant cost reductions.

The estimated increase in overall production would result from a variety of responses by the mining industry, holding constant other factors (e.g. technology, commodity prices, and political and economic conditions for mining in other countries). Some deposits considered to be subeconomic might under the State Management Alternative be considered economically feasible with a higher likelihood for development, either as extensions of existing mines or as new mines. Or more new mines might come on-line due to increased exploration or lower costs for obtaining permits.

Commodity prices would not be likely to change in response to a 5% overall increase in production because prices for most mineral commodities are determined on world markets and individual production decisions do not affect prices. For commodities whose prices are not determined on world markets (such as some of the industrial minerals), it is assumed that the prices are established on local markets and increases in production from public lands would not be sufficient to affect these prices.

Rural communities might or might not be affected, depending on a variety of factors: the level of current local mining; a community's degree of dependency or "specialization" in mining subject to the 3809 regulations; and the size of the community, its isolation, and other factors. Except in Nevada, small rural communities in most states are expected to experience only a small increase in number of jobs and output relative to overall employment and output levels. Increases might be due to expanding existing operations or starting new operations. Small expansions or small new mines might little affect communities whose population and labor force are already in place to fill new jobs. Smaller, more-isolated communities experiencing a new mine might suffer "growing pains" and new demands on local services from a large influx of new workers and their families.

In Nevada, impacts to rural communities might be greater than in other states due to the greater estimated increase in activity (up to 550 jobs and $90 million in industry output). But again, the impact to any particular community in the state would depend on whether the impact is due to the expansion of existing operations or to entirely new operations. Many of the more established communities (e.g. Elko/Eureka Counties, Humboldt County) might be better equipped to handle an influx of new jobs of this magnitude because they have had more experience with mining-induced growth over the past 20 years. Nevertheless, significant impacts might result.

The estimates of impacts assume full implementation of the alternative and no significant changes in current state requirements. Any impacts at the community level would not likely occur in the short term since new mining operations and expansions would take some time to come online.

Alternative 2 (State Management) Estimated Total Regional Economic Activity from Production of Locatable Minerals on Federal Lands ($000)												
Table 3-37 **State**	**Value of Production**		**Total Industry Output**		**Personal Income**				**Value Added**		**Number of Jobs**	
					Total		**Employee Compensation**					
Level of Impact	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Alaska	$118,000	$124,000	$144,000	$151,000	$65,900	$69,200	$30,500	$32,000	$83,800	$88,000	970	1,020
Arizona	49,900	52,300	40,600	42,600	20,500	21,500	12,200	12,800	24,100	25,300	320	340
California	97,100	102,000	142,000	150,000	76,500	80,300	46,500	48,800	83,800	88,000	1,020	1,070
Colorado	40,000	42,000	57,600	60,500	28,400	29,800	16,300	17,100	33,800	35,500	350	370
Idaho	55,300	58,100	69,400	72,900	35,300	37,100	20,700	21,700	41,800	43,900	680	710
Montana	45,900	48,200	61,700	64,800	29,300	30,800	18,200	19,100	37,600	39,500	410	430
Nevada	1,170,000	1,230,000	1,810,000	1,900,000	830,000	871,000	466,000	490,000	908,000	953,000	10,74	11,280
New Mexico	25,600	26,900	32,000	33,600	12,000	12,600	5,500	5,780	16,600	17,400	0	230
Oregon	2,010	2,110	1,250	1,310	500	525	900	945	1,000	1,050	220	11
Utah	70,300	73,900	49,200	51,700	20,900	21,900	11,100	11,700	25,700	27,000	10	380
Washington	18,300	19,300	19,900	20,900	11,900	12,500	7,600	7,980	13,300	14,000	360	140
Wyoming	5,240	5,510	3,500	3,680	1,800	1,890	900	945	2,500	2,630	130	30
Study-Area Total	$1,700,00	$1,780,000	$3,080,000	$3,230,000	$1,390,00	$1,460,000	$766,000	$804,000	$1,590,00	$1,670,000	30	22,380
	0				0				0		21,31	
											0	

Estimated Change in Regional Economic Activity from Current Conditions ($000)												
State	Value of Production		Total Industry Output		**Personal Income**				**Value Added**		**Number of Jobs**	
					Total		**Employee Compensation**					
Level of Impact	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Alaska	$0	$5,910	$0	$7,190	$0	$3,300	$0	$1,530	$0	$4,190	0	50
Arizona	0	2,490	0	2,030	0	1,030	0	610	0	1,210	0	16
California	0	4,850	0	7,120	0	3,830	0	2,330	0	4,190	0	50
Colorado	0	2,000	0	2,880	0	1,420	0	815	0	1,690	0	18
Idaho	0	2,770	0	3,470	0	1,770	0	1,040	0	2,090	0	30
Montana	0	2,300	0	3,090	0	1,470	0	910	0	1,880	0	21
Nevada	0	58,500	0	90,400	0	41,500	0	23,300	0	45,400	0	540
New Mexico	0	1,280	0	1,600	0	600	0	275	0	830	0	11
Oregon	0	101	0	63	0	25	0	45	0	50	0	1
Utah	0	3,520	0	2,460	0	1,050	0	555	0	1,290	0	18
Washington	0	917	0	995	0	595	0	380	0	665	0	7
Wyoming	0	262	0	175	0	90	0	45	0	125	0	2
Study Area Total	$0	84,900	$0	$154,000	$0	$69,500	$0	$38,300	$0	$79,400	0	1,070

Notes: Figures rounded to three significant digits. Employment figures rounded to nearest 10, except figures under 25. Source: IMPLAN Input-Output Modeling System.

Alternative 3: Proposed Action

Under the Proposed Action, mining activity in the study area could decrease between 5% and 30% from current levels after full implementation of this alternative, and assuming current trends in mining continue for the foreseeable future. The degree of impact would vary by state depending mainly on the dominant types of mining and/or commodities mined in each state. For example, in states with relatively little metal mining (Oregon, Washington, and Wyoming), the estimated decrease in value of production would be lower (-5% to -15% in Oregon and Wyoming; -5% to -20% in Washington) than for states with relatively greater amounts of metal mining (-10% to -30% in Arizona, Colorado, Montana, Nevada, New Mexico, and Utah; -10% to -20% in Alaska; and -10% to -25% in California).

For most types of smaller exploration and mining operations (i.e. less than 5 acres), the main components of the proposed regulations affecting mining would be new administrative requirements designed to increase resource protection. For example, all mining operations, regardless of mining method used, that now have to file only Notices would under the Proposed Action be required to submit Plans of Operations.

Exploration disturbing less than 5 acres would also be required to file Plans of Operations under certain circumstances, such as if located in special status areas. This requirement would increase the workload, time, and cost of obtaining approval for mining and exploration. But the degree to which workload, time, and cost would increase would depend on the type of operation and the reason a Plan would be required instead of a Notice.

In addition, new filing requirements for Plans of Operations, such as for more data, would increase costs for data collection and possibly take more time than now is the case. Longer permitting times would also be more likely for operations within withdrawn areas because of the need for mining claim validity examinations before BLM would approve mining permits.

New requirements for bonding constitute another administrative area that would increase costs for smaller Notice-level operations. Although new bonding requirements would affect all types of operations, those most affected would be small operations (e.g. exploration, placer, small open pit, and underground). These impacts would mainly be due to bonding amounts and the requirement that the bond instrument be filed with BLM.

No longer allowing corporate guarantees to satisfy bond requirements would affect some larger operations. Current corporate guarantees would not be affected, but such guarantees would not be allowed in the future. The cost of bonding would increase for operations that use corporate guarantees. This impact would be concentrated in Nevada, where corporate guarantees are now allowed and many large mining companies are using them.

Generally, the performance standards under the proposed regulations are expected to have a relatively larger impact on future large operations (i.e. greater than 5 acres) than the administrative-type provisions. Of the performance standards, the requirement to avoid substantial irreparable and unmitigatable harm to significant resources has the greatest potential for affecting mineral activities (both large and small). In some cases, this provision could preclude operations altogether. For example, if BLM determines that avoiding substantial irreparable harm would require complete backfilling of an open pit and the operator considers that requirement infeasible, the mine would not be developed. As a another example, if determining that a proposed operation would substantially, irreparably, and unmitigatably damage “significant” cultural resources, BLM would not approve the Plan of Operations.

We assume that BLM would rarely deny a Plan of Operations or reject a Notice on the basis of the substantial irreparable harm provision for most resources. On the other hand, concerns about Native American religious and cultural issues may mean that the provision may be extensively applies as it relates to those concerns. Thus, there is great amount of uncertainty associated with the substantial irreparable harm standard.

The performance standard for pit backfilling is another provision that could affect small and large open pit operations. But the presumption of backfilling has been dropped from the Proposed Action, so the likelihood of backfilling is lower than as analyzed in the draft EIS. With respect to Nevada, the proposed backfilling provision is similar to existing requirements in that state and is expected to have little effect.

Other performance standards are also expected to affect operations, especially those addressing leaching operations, surface and ground water protection, and acid-forming-type materials. But these standards would not affect operations as much as would the standard for pit backfilling, if an operation were to be required to backfill. Standards for revegetation and protection and restoration of fish and wildlife habitat are expected to have their greatest impact on small exploration and placer projects.

The value of mine production originating from public lands under the Proposed Action is estimated to decrease by 10% to 30%, or by $169 million to $484 million across the study area. This level of decreased production would cause the following decreases across the study area:

- 2,100 to 6,050 jobs.
- $305 million to $877 million in total industry output.
- $138 million to $396 million in total personal income (of which $76 million to $218 million is employee compensation).
- $157 million to $453 million in value-added.

Table 3-38 shows the regional economic impacts by state and for the study area overall. For the study areas’s total current value-added as measured by gross state product (GSP), this $157 million to $453 million would represent a 2% to 6% decrease in GSP-related value in the metals and nonmetallic sectors.

Most states would see decreased levels of mining on public lands, ranging from \$101,000 to \$302,000 in Oregon to \$117 million to \$351 million in Nevada. Nevada's share of the loss would be 70% of the loss for the study area as a whole. With the exception of the substantial irreparable harm standard, however, Nevada's existing regulations already incorporate most of the provisions of the Proposed Action.

Further, the impacts in Nevada are based only on the portion of production coming from public lands. To the extent that the affected portion from public lands may affect a larger portion of production coming from non-BLM lands, the impacts to Nevada may be understated.

A 10% to 30% overall decline in mineral production from current levels would result from a variety of responses by the mining industry. Some potential future operations would now be considered subeconomic and therefore would not be developed. Future operations might have shorter mine lives. Or current operations that might expand under these new regulations might close sooner than they otherwise would, holding constant other factors such as technology, commodity prices, and political and economic conditions for mining in other countries. A lower level of exploration due to more restrictions would also tend to decrease opportunities for future development, so some deposits would not even be found.

Economic theory suggests that mines would cease production when operating costs exceed gross revenue. The effects on any particular firm are difficult to determine without detailed information about that firm's production costs, capital structure, and nature and extent of its activities. In the extreme case, however, some firms could decide to cease production, either permanently or until commodity prices rise enough to make production profitable. But existing operations would be "grandfathered" and would continue to operate under existing regulations. Regulations under the Proposed Action would apply only to future plans to expand existing operations, and most current operations would be unaffected.

This analysis is based on (1) BLM's best estimates of potential overall reductions in the level of production of mineral commodities and (2) estimates of increased costs borne by firms. But aggregate levels of output might not change, given more efficient mining and reclamation techniques or other changes in market conditions. Total quantity produced could remain unchanged. Alternatively, the regulatory cost burden imposed by the proposed regulations could be overwhelmed by other market forces–such as commodity prices–that might play a relatively more important role in miners' production decisions.

Further, BLM would not implement the regulations in a static environment. Both miners and BLM would probably become more efficient at complying with the regulations over time. In the long run the regulations might even create incentives for firms to seek new lower cost approaches to mining and reclamation. This is a reasonable assumption given the inclination most firms have to constantly seek least-cost technology and business practices. This assumption implies that the costs of the regulations could decline over time.

Commodity prices would not be likely to change in response to a 10% to 30% decline in production because the prices for most mineral commodities are determined on world markets and individual production decisions do not affect prices. For commodities whose prices are not determined on world markets (such as some industrial minerals) prices are assumed to be established on local markets, and changes in public land production are assumed not to affect these prices. Further, impacts to industrial mining are expected to be lower (-5% to -10%) than impacts for the study area overall.

Rural communities might or might not be affected, depending on a variety of factors: the current local level of activity; the degree of dependency or "specialization" a community may have in mining subject to proposed regulations; and the size of the community, its isolation, and other factors. Except possibly in Nevada, small rural communities in most states would lose only a small number of jobs and output relative to overall employment and output levels. And some or all of this decrease might be due to forgone future mining rather than current operations shutting down, or closing earlier than originally planned due to a reduction in economic reserves. In other words, the Proposed Action might not affect current mining in these communities, but in the future, new mines might not be developed.

In Nevada, impacts to rural communities might be greater than in other states due to the greater estimated decrease in activity (1,050 to 3,200 jobs and $181 to 543 million in industry output). But how any particular community in the state would be affected would depend on whether the impacts result from existing mines closing prematurely or potential operations not being developed. Any impacts at the community level would not likely occur in the short term while the proposed regulations are being implemented because mines with existing permits would not be affected unless they amend their Plans of Operations.

Table 3-38. Alternative 3 (Proposed Action) Estimated Total Regional Economic Activity from Production of Locatable Minerals on Federal Lands ($000)												
State	Value of Production		Total Industry Output		Personal Income				Value Added		Number of Jobs	
					Total		Employee Compensation					
Level of Impact	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Alaska	$106,000	$94,600	$129,000	$115,000	$59,300	$52,700	$27,500	$24,400	$75,400	$67,000	870	780
Arizona	44,900	34,900	36,500	28,400	18,500	14,400	11,000	8,540	21,700	16,900	290	220
California	87,400	72,800	128,000	107,000	68,900	57,400	41,900	34,900	75,400	62,900	920	770
Colorado	36,000	28,000	51,800	40,300	25,600	19,900	14,700	11,400	30,400	23,700	320	250
Idaho	49,800	44,300	62,500	55,500	31,800	28,200	18,600	16,600	37,600	33,400	610	540
Montana	41,300	32,100	55,500	43,200	26,400	20,500	16,400	12,700	33,800	26,300	370	290
Nevada	1,050,000	819,000	1,630,000	1,270,000	747,000	581,000	420,000	326,000	817,000	635,000	9,670	7,520
New Mexico	23,000	17,900	28,800	22,400	10,800	8,400	4,950	3,850	14,900	11,600	200	150
Oregon	1,910	1,710	1,190	1,060	475	425	855	765	950	850	10	9
Utah	63,300	49,200	44,300	34,400	18,800	14,600	9,990	7,770	23,100	18,000	320	250
Washington	17,400	14,700	18,900	15,900	11,300	9,520	7,220	6,080	12,600	10,600	120	100
Wyoming	4,980	4,460	3,330	2,980	1,710	1,530	855	765	2,380	2,130	30	30
Study-Area Total	$1,530,000	$1,210,000	$2,770,000	$2,200,000	$1,250,000	$994,000	$690,000	$548,000	$1,430,000	$1,140,000	19,200	15,240

Estimated Change in Regional Economic Activity from Current Conditions ($000)

State	Value of Production		Total Industry Output		Personal Income				Value Added		Number of Jobs	
					Total		Employee Compensation					
Level of Impact	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Alaska	($11,800)	($23,600)	($14,400)	($28,800)	($6,950)	($13,200)	($3,050)	($6,100)	($8,380)	($16,800)	(100)	(190)
Arizona	(5,000)	(15,000)	(4,060)	(12,200)	(2,050)	(6,150)	(1,220)	(3,660)	(2,410)	(7,230)	(30)	(100)
California	(9,710)	(24,300)	(14,200)	(35,600)	(7,650)	(19,100)	(4,650)	(11,600)	(8,380)	(21,000)	(100)	(260)
Colorado	(4,000)	(12,000)	(5,760)	(17,300)	(2,840)	(8,520)	(1,630)	(4,890)	(3,380)	(10,100)	(40)	(110)
Idaho	(5,530)	(11,100)	(6,940)	(13,900)	(3,530)	(7,060)	(2,070)	(4,140)	(4,180)	(8,360)	(70)	(140)
Montana	(4,590)	(13,800)	(6,170)	(18,500)	(2,930)	(8,790)	(1,820)	(5,460)	(3,760)	(11,300)	(40)	(120)
Nevada	(117,000)	(351,000)	(181,000)	(543,000)	(83,000)	(249,000)	(46,600)	(140,000)	(90,800)	(272,000)	(1,070)	(3,220)
New Mexico	(2,560)	(7,670)	(3,200)	(9,600)	(1,200)	(3,600)	(550)	(1,650)	(1,660)	(4,980)	(22)	(70)
Oregon	(101)	(302)	(63)	(188)	(25)	(75)	(45)	(135)	(50)	(150)	(1)	(2)
Utah	(7,040)	(21,100)	(4,920)	(14,800)	(2,090)	(6,270)	(1,110)	(3,330)	(2,570)	(7,710)	(40)	(110)
Washington	(917)	(3,670)	(995)	(3,990)	(595)	(2,380)	(380)	(1,520)	(665)	(2,660)	(7)	(30)
Wyoming	(262)	(787)	(175)	(525)	(90)	(270)	(45)	(135)	(125)	(375)	(2)	(5)
Study Area Total	($169,000)	($484,000)	($305,000)	($877,000)	($138,000)	($396,000)	($75,800)	($218,000)	($157,000)	($453,000)	(2,110)	(6,070)

Notes: Figures rounded to three significant digits. Employment figures rounded to nearest 10, except figures under 25. Source: IMPLAN Input-Output Modeling System.

Alternative 4: Maximum Protection

Mineral production across the study area could decrease between 10% and 75% from current levels after full implementation of Alternative 4, depending on the mining method used. Open pit mining is expected to be affected most heavily (a decrease of 50% to 75%). Exploration is estimated to decrease by 20% to 30%, placer mining by 15% to 30%, underground mining by 10% to 25%, and strip mining by 10% to 25%.

Generally, the performance standards would have the greatest impact on the economy. They would most heavily affect open pit and large underground mines, which include most of the precious- and base-metal operations. Each performance standard would have the potential to significantly affect current and future operations, although not to the same degree. Mandatory pit backfilling, for example, would substantially increase costs for most open pit mines because most operations do not backfill or they backfill only partially. Provisions for surface and ground water protection, and for acid-producing processes would also substantially affect open pit and underground mines, making some proposed operations infeasible.

For a variety of reasons the administrative provisions under Maximum Protection are expected to affect placer mining, small exploration, and small underground operations relatively more than would the performance standard provisions. The administrative provisions likely to cause the greatest effects are the following:

- Eliminating Notice-level operations for disturbances of less than 5 acres during a calendar year.
- Validity exams and economic feasibility analyses.
- Bonding requirements.
- The requirement that all existing operations comply with the provisions of this alternative (no "grandfather" provision).

The requirement to submit Plans of Operations regardless of potential acreage disturbed would affect most current small operations and all potential future operations that would otherwise have filed Notices under the existing regulations. These operations would be required to give more information, would be subject to more agency and public involvement, and would have to obtain agency approval before proceeding.

The requirement to conduct validity exams and economic feasibility analyses would affect all types of proposed operations except for exploration. This requirement would cause permitting delays and impose more analysis costs on both BLM and applicants. Bonding for unplanned events could also add substantial costs to some operations.

The "no grandfathering" provision would potentially have a large effect on many existing operations, mainly large metal mines. But the provision also allows for some exceptions for technical, environmental, safety, or economic reasons.

Also, the provision for Native American concurrence on Plan approval would affect all operations in cases where Native American traditional cultural values may be impacted.

The performance standards are expected to affect open pit mining and large exploration and large underground operations relatively more than would the administrative provisions. Although all performance standards are expected to affect operations, probably the greatest relative impact would be due to mandatory pit backfilling, water treatment provisions, and unsuitability criteria for certain mineral deposits.

Overall, under Alternative 4, the value of mine production of locatable minerals would decrease by from 46% to 69%, or $773 million to $1.2 billion across the study area. This level of decreased production would cause the following decreases:

- 9,700 to 14,600 jobs.
- $1.4 billion to $2.1 billion in total industry output
- $633 million to $955 million in total personal income (of which $349 million to $526 million is employee compensation).
- $723 million to $1.1 billion in value-added.

Table 3-39 shows the regional economic impacts by state and for the study area overall. For the study areas's total current value-added as measured by gross state product (GSP), this $723 million to $1.1 billion would represent a 10% to 14% decrease in GSP-related value in the metals and nonmetallic sectors.

All states would face decreased levels of activity on public lands, but to differing degrees depending on the mining method most prevalent in the state. Open pit mining would be more significantly affected than other types of mining. And states where open pit mining dominates on public lands would be relatively more affected. Of the total value of production from federal land, gold makes up 85% ($1.4 billion in gold production out of $1.7 billion for all minerals). And most of this gold production comes from open pit mining–the mining method most heavily affected by Maximum Protection. Most of this gold production, and open pit mining in general, is concentrated in just a few states.

Although most states have open pit mines, six states are likely to be most affected: Arizona, Colorado, Montana, Nevada, New Mexico, and Utah. In these states, production levels are estimated to decline by 50% to 75% from current levels. This decline represents the following loss in production value:

- $24.9 million to $37.4 million for Arizona.
- $20 million to $30 million for Colorado.
- $22.9 million to 34.4 million for Montana.
- $585 million to $877 million for Nevada.
- $12.8 million to $19.2 million for New Mexico.

- $35.2 million to $52.8 million for Utah.

The other states would be affected to lesser but varying degrees, by percentage change in value of production. In Alaska, most current production from BLM-administered lands comes from placer mining, which would decrease from current levels by 20% to 30%, or $23.6 million to $35.5 million, Production in California would decrease by 30% to 50% ($29.1 million to $48.5 million) due to a greater level of industrial mineral production relative to open pit production.

Industrial minerals production mainly uses strip mining methods, which would be subject to fewer restrictions than open pit methods. In Idaho, production would decrease by 25% to 40% overall, or by $13.8 million to $22.1 million. This amount reflects Idaho's mix of open pit and underground operations. Idaho tends to have a greater proportion of underground mines than the study area overall, and underground mines would be less affected than would open pit mines.

In Oregon and Wyoming most production involves industrial minerals. The estimated decrease in production for both states is 10% to 20% ($201,000 to $402,000 in Oregon and $524,000 to $1 million in Wyoming). In Washington production would decrease by 25% to 40% ($4.6 million to $7.3 million), given its mix of open pit metals operations and industrial mineral mines, which are more apt to use strip methods. Impacts in Table 3-39 reflect these differences.

Nevada, with its concentration of open pit gold mines, would face the greatest reduction in activity, a $585 million to $877 million decrease in production value. This decrease would create a $904 to $1.4 billion decrease in industry output and a loss of 5,370 to 8,060 jobs.

Across the study area, an overall decline of 10% to 75% in mineral production, depending on mining methods, would result from a variety of responses by the mining industry. Because of the "no grandfather" provision, many current operations might close down if they could not comply with the provisions of the Maximum Protection Alternative. But this provision does allow some exceptions for technical, environmental, safety, or economic reasons.

Some potential future operations would then be considered subeconomic and would not be developed. Future operations might have shorter mine lives. Or current operations that might expand under these new regulations might close sooner, holding constant other factors (e.g. technology, commodity prices, and political and economic conditions for mining in other countries).

The level of decrease in activity assumed under Alternative 4 would also likely cause decreased exploration in the study area for two reasons. First, exploration would be directly affected by the provisions of this alternative. All exploration projects would be required to file Plans of Operations and meet the provisions of the performance standards. These provisions could substantially increase exploration costs and thus decrease activity. Second, and possibly more important, the expected decrease in mining due to more restrictive performance and design standards would decrease the desirability of exploring for new or expanded deposits in the study area. Consequently, exploration on non-BLM-administered lands or foreign countries might become relatively more attractive.

Rural communities where locatable minerals are now being mined could also be substantially affected. Because existing operations would not be grandfathered, many of these operations could incur significant costs to comply with this alternative's provisions. Where operations could absorb these costs, mines lives might be shortened if portions of the ore deposit become uneconomic and higher graded deposits could not be found. Other operations could not absorb these costs and would shut down completely.

The extent to which communities would be affected would depend on a variety of factors: the level of local current activity; the community's dependence on mining subject to 3809 regulations; whether existing operations could meet the more restrictive requirements; and the size of the community, its isolation, and other factors. In small, isolated communities with a high degree of specialization in mining, the impact of a mine shutting down would be significant. Larger communities with a lesser degree of specialization in mining would be less affected. Nevada communities would have the greatest potential for significant impact given the high degree of specialization in metal mining–the type of mining likely to be affected most.

The extent to which commodity prices might be affected under Maximum Protection is unknown. Gold production is likely to be most heavily affected because most gold production on public lands comes from open pit mines. An estimated 40% of all domestic gold production comes from federal land (including land managed by agencies other than BLM), with a estimated value of $1.44 billion (see Table 3-31). A 50% to 75% decrease of this 40% means that total domestic production would decrease by 20% to 30%. A 20% to 30% decline in domestic production would translate to a 3% to 4.5% decrease in worldwide production at current worldwide production levels. Given recent projections for the rate of growth in production worldwide (1.3% to 3% per year), a 3% to 4.5% decline falls just above this range of variability.

A supply decline of this magnitude could create a short-term increase in the price of gold, holding other factors affecting price constant (such as changes in production technology and worldwide demand) until more production could come online to offset the decline in U.S. production.

Prices for other commodities are not likely to be affected for a two reasons: (1) A lower proportion of total domestic production comes from BLM-administered land for most of these minerals, and (2) these minerals use a wide variety of mining methods and rely less on open pit methods for extraction.

Alternative 4 (Maximum Protection) Estimated Total Regional Economic Activity from Production of Locatable Minerals on Federal Lands ($000)

Table 3-39

State	Value of Production		Total Industry Output		Personal Income				Value Added		Number of Jobs	
					Total		Employee Compensation					
Level of Impact	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Alaska	$94,600	$82,700	$115,000	$101,000	$52,700	$46,100	$24,400	$21,400	$67,000	$58,700	780	680
Arizona	24,900	12,500	20,300	10,200	10,300	5,130	6,100	3,050	12,100	6,030	160	80
California	68,000	48,500	99,700	71,200	53,600	38,300	32,600	23,300	58,700	41,900	710	510
Colorado	20,000	9,990	28,800	14,400	14,200	7,100	8,150	4,080	16,900	8,450	180	90
Idaho	41,500	33,200	52,000	41,600	26,500	21,200	15,500	12,400	31,400	25,100	510	410
Montana	22,900	11,500	30,900	15,400	14,700	7,330	9,100	4,550	18,800	9,400	210	100
Nevada	585,000	292,000	904,000	452,000	415,000	207,000	233,000	117,000	454,000	227,000	5,370	2,690
New Mexico	12,800	6,390	16,000	8,000	6,000	3,000	2,750	1,380	8,300	4,150	110	60
Oregon	1,810	1,610	1,130	1,000	450	400	810	720	900	800	9	8
Utah	35,200	17,600	24,600	12,300	10,500	5,230	5,550	2,780	12,900	6,430	180	90
Washington	13,800	11,000	14,900	11,900	8,930	7,140	5,700	4,560	9,980	7,980	100	80
Wyoming	4,720	4,200	3,150	2,800	1,620	1,440	810	720	2,250	2,000	30	24
Study-Area Total	$925,000	$532,000	$1,680,000	$963,000	$758,000	$435,000	$417,000	$240,000	$866,000	$497,000	11,610	6,670
Estimated Change in Regional Economic Activity from Current Conditions ($000)												
State	Value of Production		Total Industry Output		Personal Income				Value Added		Number of Jobs	
					Total		Employee Compensation					
Level of Impact	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Alaska	($23,600)	($35,500)	($28,800)	($43,100)	($13,200)	($19,800)	($6,100)	($9,150)	($16,800)	($25,100)	(190)	(290)
Arizona	(24,900)	(37,400)	(20,300)	(30,500)	(10,300)	(15,400)	(6,100)	(9,150)	(12,100)	(18,100)	(160)	(240)
California	(29,100)	(48,500)	(42,700)	(71,200)	(23,000)	(38,300)	(14,000)	(23,300)	(25,100)	(41,900)	(310)	(510)
Colorado	(20,000)	(30,000)	(28,800)	(43,200)	(14,200)	(21,300)	(8,150)	(12,200)	(16,900)	(25,400)	(180)	(260)
Idaho	(13,800)	(22,100)	(17,400)	(27,800)	(8,830)	(14,100)	(5,180)	(8,280)	(10,500)	(16,700)	(170)	(270)
Montana	(22,900)	(34,400)	(30,900)	(46,300)	(14,700)	(22,000)	(9,100)	(13,700)	(18,800)	(28,200)	(210)	(310)
Nevada	(585,000)	(877,000)	(904,000)	(1,360,000)	(415,000)	(622,000)	(233,000)	(350,000)	(454,000)	(681,000)	(5,370)	(8,060)
New Mexico	(12,800)	(19,200)	(16,000)	(24,000)	(6,000)	(9,000)	(2,750)	(4,130)	(8,300)	(12,500)	(110)	(170)
Oregon	(201)	(402)	(125)	(250)	(50)	(100)	(90)	(180)	(100)	(200)	(1)	(2)
Utah	(35,200)	(52,800)	(24,600)	(36,900)	(10,500)	(15,700)	(5,550)	(8,330)	(12,900)	(19,300)	(180)	(270)
Washington	(4,590)	(7,340)	(4,975)	(7,960)	(2,980)	(4,760)	(1,900)	(3,040)	(3,330)	(5,320)	(30)	(50)
Wyoming	(524)	(1,050)	(350)	(700)	(180)	(360)	(90)	(180)	(250)	(500)	(3)	(6)
Study Area Total	($773,000)	($1,170,000)	($1,400,000)	($2,110,000)	($633,000)	($955,000)	($349,000)	($526,000)	($723,000)	($1,090,000)	(9,700)	(14,600)

Notes: Figures rounded to three significant digits. Employment figures rounded to nearest 10, except figures under 25. Source: IMPLAN Input-Output Modeling System.

Alternative 5

After full implementation of Alternative 5, mineral activity in the study area could decrease up to 10% from current levels, assuming current trends in mining continue for the foreseeable future. The degree of impact would vary by state, depending mainly on the dominant types of mining and/or commodities mined in each state. In some states, there may be no impact. For example, in states with relatively more metal mining and where larger operations are concentrated (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, and Utah), the estimated decrease in value of production would be 0 to -5%. For those states with relatively more small operations (Alaska, California, Washington, and Wyoming), the impacts would be greater, an estimated decrease of -5% to -10%.

For small mining operations (i.e. less than 5 acres), the provisions of Alternative 5 that would create the greatest impact are the administrative requirements designed to increase resource protection. Specifically, all Notice-level mining would be required to submit Plans of Operations. Exploration disturbing less than 5 acres in special status areas would also have to file Plans of Operations

These new requirements for small operations would increase the workload, time, and cost of obtaining approval for mining and exploration. But the degree to which these factors (workload, time, and cost) would increase would depend on the type of operation and the reason a Plan would be required instead of a Notice.

In addition, new filing requirements for Plans of Operations, such as more data, would increase costs for data collection and possibly take more time than currently is the case.

New requirements for bonding constitute another administrative area that would increase costs for smaller Notice-level operations. Although new bonding requirements would affect all types of operations, those most affected would be small operations (e.g. exploration, placer, small open pit, and underground). These impacts would mainly be due to bonding amounts and the requirement that the bond instrument be filed with BLM.

Eliminating corporate guarantees to satisfy bond requirements would affect some larger operations. Current corporate guarantees would not be affected, but corporate guarantees would not be allowed in the future. The cost of bonding would thus increase for operations that use corporate guarantees. This impact would be concentrated in Nevada, where corporate guarantees are now allowed and are used by large mining companies.

The value of mine production originating from public lands under Alternative 5 is estimated to decrease by up to 10%, or $12 million to $100 million across the study area. This level of decreased production would cause the following decreases:

- 150 to 1,260 jobs to the region.
- $21.5 million to $182 million in total industry output.
- $9.7 million to $82 million in total personal income (of which $5.4 million to $45.2 million is employee compensation).
- $11.1 million to $93.7 million in value-added.

Table 3-40 shows the regional economic impacts by state and for the study area overall. For the study areas's total current value-added as measured by gross state product (GSP), this $11.1 million to $93.7 million would represent a 0.1% to 1.2% decrease in GSP-related value in the metals and nonmetallic sectors.

Most states would see decreased levels of mineral production value on public lands, ranging from $100 thousand to $200 thousand in Oregon to $0 to $58.5 million in Nevada. Nevada's share of the loss would be 58% of the loss for the study area as a whole. But Nevada's existing regulations already incorporate most of the provisions of Alternative 5, so the estimated 5% decline in that state's production might be overstated. On the other hand, the impacts in Nevada are based only on the portion of production coming from public lands. To the extent that the affected portion from public lands might affect a larger portion of production from non-BLM lands, the impacts to Nevada may be understated.

A variety of responses by the mining industry would result in a decline of up to10% from current levels overall in mineral production across the study area:

- Some potential future operations would be considered subeconomic and therefore would not be developed.
- Future operations might have shorter mine lives.
- Current operations that might expand under these new regulations might close sooner than they otherwise would, holding constant such factors as technology, commodity prices, and political and economic conditions for mining in other countries.
- Because of more restrictions, less exploration would decrease opportunities for future development, so some deposits would not even be found.

This analysis is based on BLM's best estimates of potential overall reductions in the level of production of mineral commodities and estimates of increased costs borne by firms. But aggregate levels of output might not change, given more efficient mining and reclamation techniques or other changes in market conditions. Total quantity produced could remain unchanged. Alternatively, the regulatory cost burden imposed by the proposed regulations could be overwhelmed by other market forces–such as commodity prices–that might play a relatively more important role in miners' production decisions.

Further, BLM would not implement the regulations in a static environment. Both miners and BLM would probably become more efficient at complying with the regulations over time. In the long run the regulations might even create incentives for firms to seek new lower cost approaches to mining and reclamation. This is a reasonable assumption given the inclination most firms have to constantly seek least-cost technology and business practices. This assumption implies that the costs of the regulations could decline over time.

Commodity prices would not be likely to change in response to a decline of 0% to 10% in production because the prices for most mineral commodities are determined on world markets and individual production decisions do not affect prices. For commodities whose prices are not determined on world markets (such as some of industrial minerals), prices are assumed to be established on local markets, and changes in public land production are assumed not to affect these prices.

Rural communities might or might not be affected, depending on a variety of factors: the current local level of activity; the degree of dependency or "specialization" a community may have in mining subject to 3809 regulations; and the size of the community, its isolation, and other factors. Small rural communities in most states would lose only a small number of jobs and output relative to overall employment and output levels. And some or all of this decrease might be due to forgone future mining rather than current operations shutting down, or closing earlier than originally planned due to a reduction in economic reserves. In other words, Alternative 5 might not affect current mining in these communities, but new operations in the future might not be developed.

In Nevada, impacts to rural communities might be greater than in other states due to the greater estimated decrease in activity (up to 540 jobs and $90.4 million in total industry output). But the impact to any particular community in the state would depend on whether it results from existing mines closing prematurely or potential future operations not being developed. Any impacts at the community level would not likely occur in the short term while the proposed regulations are being implemented because mines with existing permits would not be affected unless they submit amendments to their Plans of Operations. But Nevada's existing regulations already incorporate most of the provisions of Alternative 5, so the estimated 5% decline in production might be overstated.

Table 3-40. Alternative 5 (NRC Recommendations) Estimated Total Regional Economic Activity from Production of Locatable Minerals on Federal Lands ($000)												
State	Value of Production		Total Industry Output		Personal Income				Value Added		Number of Jobs	
					Total		Employee Compensation					
Level of Impact	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Alaska	$112,000	$106,000	$137,000	$129,000	$62,600	$59,300	$29,000	$27,500	$79,600	$75,400	920	870
Arizona	49,900	47,400	40,600	38,600	20,500	19,500	12,200	11,600	24,100	22,900	320	300
California	92,200	87,400	135,000	128,000	72,700	68,900	44,200	41,900	79,600	75,400	970	920
Colorado	40,000	38,000	57,600	54,700	28,400	27,000	16,300	15,500	33,800	32,100	350	330
Idaho	55,300	49,800	69,400	62,500	35,300	31,800	20,700	18,600	41,800	37,600	680	610
Montana	45,900	43,600	61,700	58,600	29,300	27,800	18,200	17,300	37,600	35,700	410	390
Nevada	1,170,000	1,110,000	1,810,000	1,720,000	830,000	788,000	466,000	443,000	908,000	862,000	10,700	10,200
New Mexico	25,600	24,300	32,000	30,400	12,000	11,400	5,500	5,230	16,600	15,800	220	210
Oregon	1,910	1,810	1,190	1,130	475	450	855	810	950	900	10	9
Utah	70,300	66,800	49,200	46,700	20,900	19,900	11,100	10,500	25,700	24,400	360	340
Washington	17,400	16,500	18,900	17,900	11,300	10,700	7,220	6,840	12,600	12,000	120	120
Wyoming	4,980	4,720	3,330	3,150	1,710	1,620	855	810	2,380	2,250	30	30
Study Area Total	$1,690,000	$1,600,000	$3,060,000	$2,990,000	$1,380,000	$1,310,000	$761,000	$721,000	$1,580,000	$1,490,000	21,160	20,050
Estimated Change in Regional Economic Activity from Current Conditions ($000)												
State	Value of Production		Total Industry Output		Personal Income				Value Added		Number of Jobs	
					Total		Employee Compensation					
Level of Impact	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Alaska	($5,910)	($11,800)	($7,190)	($14,400)	($3,300)	($6,590)	($1,530)	($3,050)	(4,190)	($8,380)	(50)	(100)
Arizona	0	(2,490)	0	(2,030)	0	(1,030)	0	(610)	0	(1,210)	0	(16)
California	(4,850)	(9,710)	(7,120)	(14,200)	(3,830)	(7,650)	(2,330)	(4,650)	(4,190)	(8,380)	(50)	(100)
Colorado	0	(2,000)	0	(2,880)	0	(1,420)	0	(815)	0	(1,690)	0	(18)
Idaho	0	(5,530)	0	(6,940)	0	(3,530)	0	(2,070)	0	(4,180)	0	(70)
Montana	0	(2,300)	0	(3,090)	0	(1,470)	0	(910)	0	(1,880)	0	(21)
Nevada	0	(58,500)	0	(90,400)	0	(41,500)	0	(23,300)	0	(45,400)	0	(540)
New Mexico	0	(1,280)	0	(1,600)	0	(600)	0	(275)	0	(830)	0	(11)
Oregon	(101)	(201)	(63)	(125)	(25)	(50)	(45)	(90)	(50)	(100)	(1)	(1)
Utah	0	(3,520)	0	(2,460)	0	(1,050)	0	(555)	0	(1,290)	0	(18)
Washington	(917)	(1,840)	(995)	(1,990)	(595)	(1,190)	(380)	(760)	(665)	(1,330)	(7)	(13)
Wyoming	(262)	(524)	(175)	(350)	(90)	(180)	(45)	(90)	(125)	(250)	(2)	(3)
Study Area Total	($12,000)	($99,700)	($21,500)	($182,000)	($9,730)	($82,000)	($5,360)	($45,200)	($11,100)	($93,700)	(150)	(1,260)

Notes: Figures rounded to three significant digits. Employment figures rounded to nearest 10, except figures under 25. Source: IMPLAN Input-Output Modeling System.